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larssen

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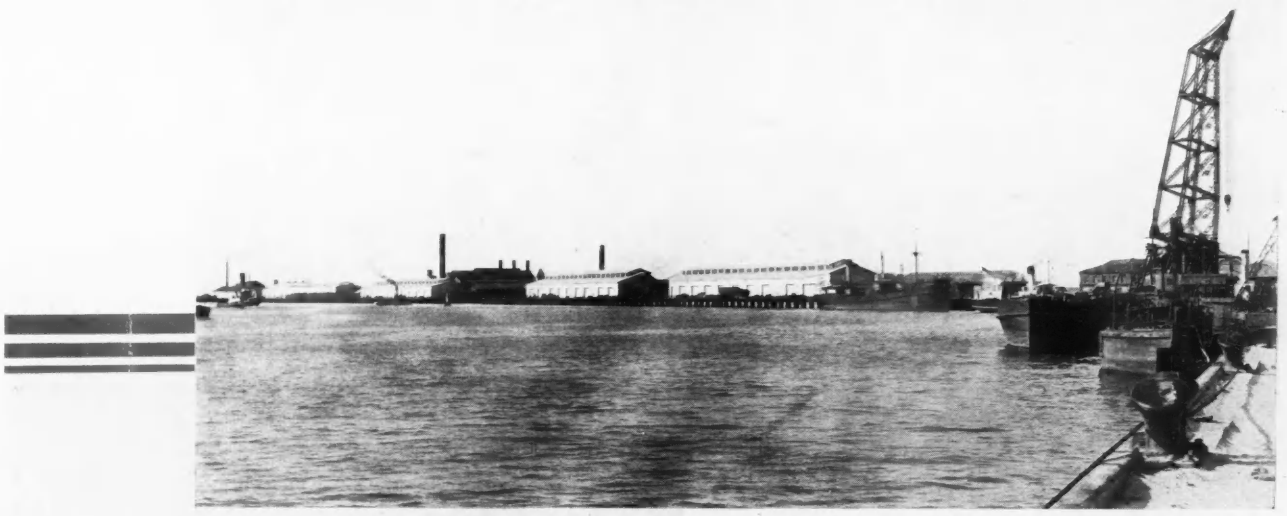

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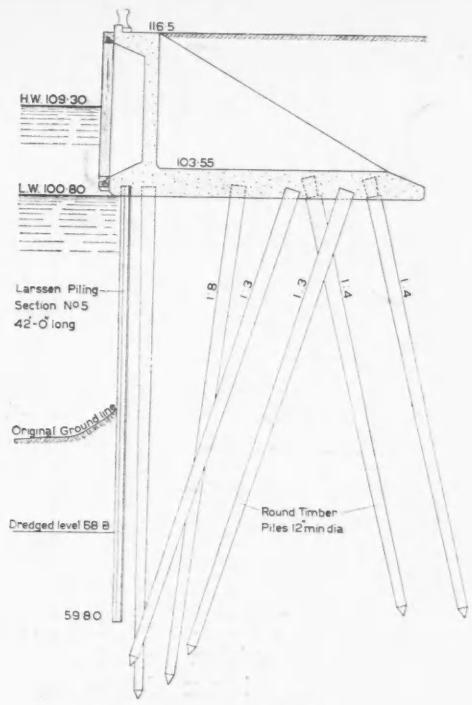

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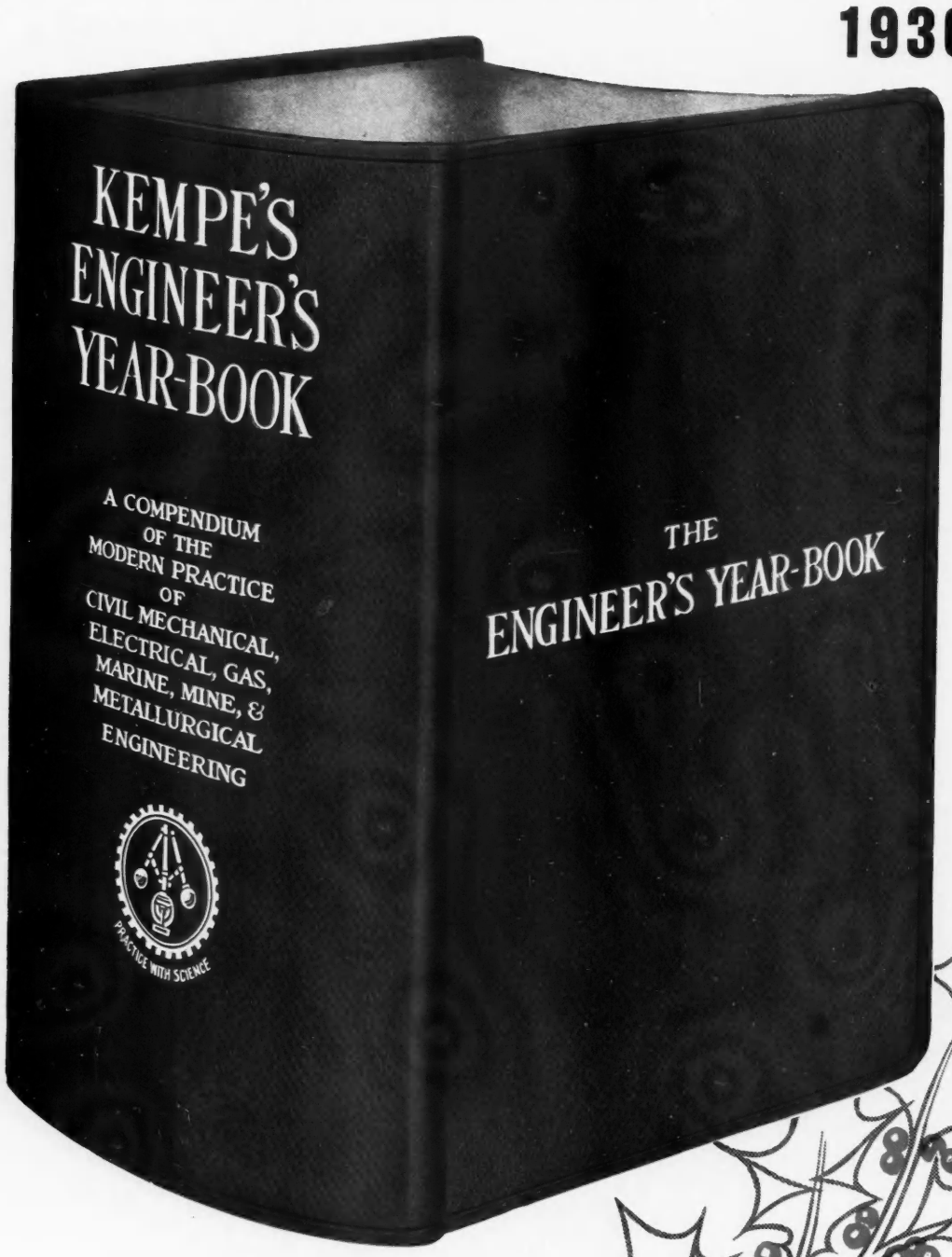

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A New Destroyer Flotilla.

ANSWERING a question in the House of Commons on Wednesday, December 11th, Lord Stanley, the Parliamentary Secretary to the Admiralty, announced that it was proposed to order a further flotilla of seven destroyers later in the financial year, for which a Supplementary Estimate would be presented. That Estimate, he added, would provide for the flotilla and for some small vessels which had been recently ordered for the Royal Navy as additions to the 1935 programme. The vessels above referred to are in addition to the flotilla leader and the eight destroyers of the 1935 programme recently ordered, which will be laid down in the course of the next few months. The new flotilla will enable further over-age destroyers, most of which were built during the war, to be replaced. The construction of this particular class of naval craft is less restricted than that of other naval vessels because of the tonnage still available to this country under the London Treaty. In connection with the smaller vessels of the 1935 programme, it may be stated that the Admiralty has decided, subject to the settlement of certain points of detail, to entrust the construction of the two coastal sloops, H.M.S. "Sheldrake" and "Kittiwake," to John I. Thornycroft and Co., Ltd., of Woolston, Southampton.

The Railways (Agreement) Bill.

THE second reading of the Railways (Agreement) Bill was moved by the Chancellor of the Exchequer on Friday, December 13th. Mr. Chamberlain said that the first clause empowered the Treasury to guarantee the principal and interest on the securities which were to be issued by the finance company to be formed by the Treasury. The railway case was well stated by Sir Robert Horne, who did useful public service by showing the difference between the financial propositions under the present Bill and those of the Development (Loan Guarantee and Grants) Act, 1929. By the former the Government was only putting its credit behind the railways and enabling them to borrow more cheaply without any expense to the taxpayer; under the 1929 Act the Government gave hard cash to the railway companies in defraying interest charges on the loans. Some of the subsequent speakers urged the formation of a national transport trust to include all forms of transport because of "the phenomenal success of the London Transport Board." On the other hand, a Unionist Member said that no Minister could control all the forms of transport from one office; amalgamations came too soon, and three of the railways were still suffering from indigestion. The Bill was eventually read a second time, and sent to a Committee of the whole House. On Monday, December 16th, there was some further discussion of the Bill, and the claims of the special areas and the control of finance were dealt with. The Committee stage was concluded, and the Bill was reported without amendment to the House. The Bill was read a third time on Tuesday last.

American Liner Construction.

THE contract for the construction of a new Atlantic liner of 33,000 gross tons, to replace the "Leviathan," which was laid up last year, was signed on Monday, December 16th, by Mr. J. M. Franklin, vice-president of United States Lines. The new ship will be constructed by the Newport News Shipbuilding and Dry Dock Company at Newport News. She will be of a similar class to the "Manhattan" and the "Washington" and will be operated in the company's cabin ship service between New York and Europe. The cost of the ship is given as about £2,500,000. Some 1500 men will be employed in her construction, and it is expected that she will be finished in twenty-eight months. During the past week Mr. Paul W. Chapman, a former president of the United States Lines, discussed the building of two 100,000-ton single-class liners, at an estimated cost of £20,000,000. These ships, if built, would have no less than 5000 cabins, and the design provides for telescoping funnels and the provision of a space 800ft. in length and 140ft. wide for the landing and taking off of aeroplanes. If financial assistance is forthcoming within six months, Mr. Chapman anticipates that the ships could be launched in the autumn of 1938.

British Chemical Standards.

THE report of the Bureau of Analysed Samples, Ltd., of 3, Wilson-street, Middlesbrough, covering the four years from September, 1931, to September, 1935, has just been issued, and shows rapid progress in the pioneer movement established in 1916 for the establishment of a British Bureau of Chemical Standards. Until November 30th the work was carried on by the late Mr. C. H. Ridsdale, the founder of the movement, but at a meeting held in York on November 30th it was decided to form a private limited company under the title of the Bureau of Analysed Samples, Ltd., which would enable those interested in the movement to be more fully represented in its activities and to co-operate more closely with other kindred bodies, such as the British Standards Institution, which is issuing an increasing number of chemical specifications, but no standard analysed samples. At the present time thirty-four Chemical Standard Samples are available, and 269 standardised elements; special Analysed Samples for standards are also available. The total number of co-operating firms and analysts is now 112, of which twenty-four are abroad. In the case of turnings of standard steels for sulphur estimation, it has been found that micro-oxidation prevents the full yield of sulphur. It has now been decided to prepare at frequent intervals fresh turnings of a high and a low standard which, if used within six months, will give the full sulphur yield. There has been an increased demand for 500-gram samples, as well as the 100-gram, 50-gram, and 25-gram samples, and these can now be obtained either direct from the Bureau or from chemical dealers and laboratory furnishers. It is claimed that the further extension in the use of British Chemical Standards has fostered a greater measure of good will and mutual understanding between analytical chemists and has encouraged fair dealing in the buying and selling of steel, pig iron, and ore, while mistakes have been prevented and in other cases detected and corrected.

The French Liner L'Atlantique.

AFTER a period of close upon three years, there seems to be some prospect of ending the various claims arising out of the fire on the French liner "L'Atlantique," which took place between Cherbourg and Le Havre on January 4th, 1933. On Tuesday, December 10th, the French Court of Cassation dismissed the appeal of the underwriters, representing no less than ninety-three companies, against the judgment given against them, and confirmed the order that the underwriters should pay 170,000,000f., or about £2,260,000, plus interest at 6 per cent., together with costs, to the Compagnie Sud Atlantique, the owners of the ship. It is also announced that the various claims by five salvage companies which brought the burned-out hulk to Cherbourg after the fire shall be settled by arbitration. The companies, three French, one German, and one Dutch, are claiming about 50,000,000f., or about £670,000, for their services. It has been now agreed that Maitre Leopold d'Or, who represented the owners, and Maitre de Grandmaison, who was chosen as arbitrator for the salvage companies, shall together give a decision on the claims, which is to be final. The way in which the sum allotted is to be divided between the five claimants is to be entrusted to Maitre Leopold d'Or alone. When the whole of the claims have been settled, it is probable that the order for a replace ship will be placed.

The Naval Conference.

IN last week's Journal we recorded the official opening of the five-power Naval Conference. During the week under review progress has been made towards a better understanding on the difficult subject of quantitative limitation. At last week's meetings and at that on Monday, December 16th, the proposals of the Japanese delegation for a "common upper limit" of tonnage in naval armaments were fully discussed, and at Monday's meeting Admiral Nagano gave further explanations of the Japanese plan. Japan, the Admiral stated, wanted to get rid of large and expensive ships and to ensure that all navies, including her own, were fitted only for defence purposes. Her objective, he claimed, was real disarmament. Tuesday's meeting was important, as at it Lord Monsell, the First Lord of the Admiralty, put forward the British proposal for quantitative limitation in naval armaments. The British proposal suggests that each Power should make unilateral declarations regarding naval construction over a period of years. It seeks to recognise the clear rights of each Power to possess the armament necessary to its security, and proposes that each should base its naval strength on the minimum adequate to attain that security. Provision is made for any Power to readjust its construction programme in the event of its needs undergoing a change.

Safety in Mines.

A ROYAL COMMISSION has been appointed to examine into the question of safety in mines. Its terms of reference are to inquire whether the safety and health of mine workers can be better ensured by extending or modifying the principles or general provisions of the Coal Mines Act, 1911, or the arrangements for its administration, having regard to the changes that have taken place in organisation, methods of work, and equipment since it became law, and the experience gained, and to make recommendations. The following will form the Commission:—Lord Rockley (Chairman), Sir Malcolm Delevingne, Sir Henry Walker, Mr. D. R. Grenfell, His Honour Judge G. C. Allsebrook, Mr. E. O. F. Brown, Mr. E. Edwards, Mr. W. T. Miller, Mr. W. H. Telfer, and Mr. John Walker. The Secretary to the Commission will be Mr. E. W. Ravenshear, and the Assistant Secretary Mr. G. B. Brown, both of the Mines Department. All communications should be addressed to the Secretary, Royal Commission on Safety in Coal Mines, Romney House, Marsham-street, London, S.W.1.

Wandsworth Bridge.

THE proposals for the rebuilding of Wandsworth Bridge, as outlined in a Journal note of December 13th, were accepted by the London County Council at a meeting held on Tuesday, December 17th. At the same time the Wandsworth Borough Council approved the proposal for the continuation of the Chelsea Embankment linking Battersea and Wandsworth Bridges. The scheme was initiated by the Chelsea Council and supported by Fulham; it is now to be submitted to the L.C.C. The new scheme visualises the continuation of the embankment in front of Lots-road power station to Wandsworth Bridge. It would involve the reclamation of part of the river foreshore and the building of a viaduct over Chelsea Creek and the West London Extension Railway. Fulham Council has proposed the further extension of the embankment past the Hurlingham grounds to Putney Bridge, but this proposal is not included in the joint scheme. The extension of Chelsea Embankment has for its object the relieving of traffic congestion, which would certainly occur at this point when the new Wandsworth Bridge had been completed. At present west-going traffic on the Chelsea Embankment must turn off at Lots-road, just beyond Battersea Bridge, and enter King's-road.

Safety at Sea.

THE loss of the oil tanker "La Crescenta," to which Lord Merrivale found the "wrongful acts and defaults of the owners" had contributed, was the subject of questions in the House of Commons on Tuesday, December 17th. In his reply, Mr. Runciman said that the questions were in the main similar to those raised in the reports of earlier inquiries. The matter was already under consideration by the Merchant Shipping Advisory Committee. The observations in the report with regard to seaworthiness were similar to points raised at previous inquiries, and the matter was under discussion between the Board of Trade and the classification societies. An expert committee set up by Mr. Runciman himself in July was examining the question of the type of steering gear used in some ships which had been the subject of that inquiry. He hoped its report would reach him early in the New Year. The action to be taken would depend largely on the results of the inquiries and discussions. The reports of the Merchant Shipping Advisory Committee on Manning, of the Steering Gear Committee, and the result of the discussions between the Board of Trade and the classification societies would all be made public as soon as they were received. After consultation with the classification societies, the Board of Trade issued through the shipowner's organisations in August last recommendations to shipowners as to certain precautions that should be taken forthwith in remedying matters raised by the inquiry. Mr. Runciman then gave an assurance that he would promote legislation if it was found necessary.

Trade Returns for November.

THE Board of Trade returns for November, issued on Saturday last, December 14th, give a total value to the imports during the month of £71,455,483. They were £1,927,216 less than in October, owing largely to the difference in the number of days in the two months, the daily average being fully maintained, and were £6,798,677 greater than in November last year. British exports were valued at a total of £39,399,994, a reduction of £464,717 on the figures for October, and £3,274,730 better than in November, 1934. Re-exports were given as £4,571,952, a slightly lower figure than for October, but better by £563,662 than last year. The excess of imports over total exports for the month was £27,483,537, as against £24,523,252 in November, 1934. The aggregate value of imports for the eleven months of the year amounts to £683,571,272, an increase of £14,056,087 on last year, and of £70,719,807 compared to 1933. British exports at a total value of £391,037,481 have risen by £29,163,966 compared with last year, and by £54,025,146 compared with 1933. Re-exports at £49,821,075 show increases of £2,138,273 and £4,737,095 on a similar comparison. The total export of manufactured articles at £302,784,198 exceeded the 1934 figure by £23,596,845 and the 1933 figure by £44,252,557, nearly every class of British manufacture showing an increase. The value of British aircraft exported in November totalled £222,988, as against £131,460 in November last year. The iron and steel imported during the month amounted to £707,556, as against £693,027 in November, 1934.

Report on Test of 1400 H.P. Epicyclic Test Gear.

No. I.

BY the kindness of Mr. Alan E. L. Chorlton and the Canadian National Railways, and with the consent of William Beardmore and Co., Ltd., there has been made available to us for publication a report on a series of tests carried out on a large epicyclic gear made by Messrs. Beardmore some years ago. This report, at the time it was written, was necessarily secret and confidential. It is dated December 13th, 1926, signed by Mr. Chorlton, and addressed to Mr. C. E. Brooks, late Chief of Motive Power, the Canadian National Railways, Montreal, Canada. The complete gear was intended to be fitted to a 1400 h.p. oil engine-driven locomotive, the general design of which is shown in Fig. 1. Mr. Brooks some time earlier had become interested in the proposition of the oil engine-driven locomotive and had examined examples with mechanical and electrical transmissions. Ultimately he decided in favour of the mechanical gear, and the experimental work described in the report arose out of the submission of a design for an oil engine-driven locomotive to him. Improvements in electrical systems, together with the successes of certain railcars in Canada, ultimately resulted in the adoption by the C.N.R. of electrical transmission. But the report is nevertheless particularly interesting, as showing that one firm at least in this country was playing an active part in the development of the oil engine-driven locomotive at a time when so much of the work was being done abroad.

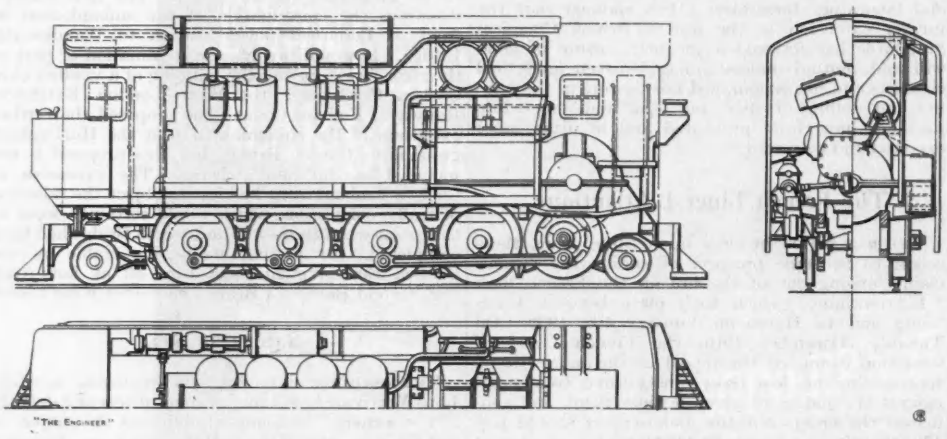


FIG. 1—ARRANGEMENT OF GEARED OIL ENGINE LOCOMOTIVE

A sectional drawing of the complete gear is reproduced in Fig. 2. It was of the seven planet epicyclic type and multiple clutches were used to engage the different speeds. It was desired to allow for comparatively long periods of slipping of the clutches at times of starting or changing gear and the arrangement adopted overcame the heat dissipation difficulty with the aid of a through circulation of oil. The clutches were actuated hydraulically, their control being effected by a single master hydraulic switch, so that, as far as the driver was concerned, the mere turning of a handle to a new position either started the locomotive or changed the gear ratio. The straightforward step-by-step gear-box is likely to fail when applied to heavy rail locomotives on account of the break in traction each time the gear ratio is changed. It was therefore necessary that the change gear mechanism should function gradually and that, in fact, controlled slipping of the clutches should take place so that no jerk or lack of continuity of tractive effort would be felt by the train. For these reasons hydraulic rams were utilised, not only to push the clutch discs gradually into contact, but also for disengaging them.

The service which the locomotive had to perform was that of train formation under difficult conditions and haulage from Mimico to Darnforth, near Toronto, with loads up to 3000 tons. In this service not only was great tractive power required, but also an ability to break out a train with frozen axles, and considerable flexibility of operation. Curves of tractive effort at the rail for which the gear was designed are reproduced in Fig. 3. The mechanical construction of the gear was in all parts kept as solid and substantial as possible in order that it should stand up to the rough work of locomotive practice. For the clutches a combined woven material with wire matt inside was used. It was supplied by Small and Parkes, Ltd., and was fixed in pads in the one set of plates which acted against specially cut steel intermediary plates.

Several special precautionary devices were incorporated in the design of the locomotive. One, consisting of a spring coupling whose angle of movement released the pressure on the driving clutches, acted to prevent the stalling of the engine under overloads. Another, dependent upon the engine speed and rail speed, automatically controlled the gear changes so that the driver had no more to do than has the electric motorman in a suburban train.

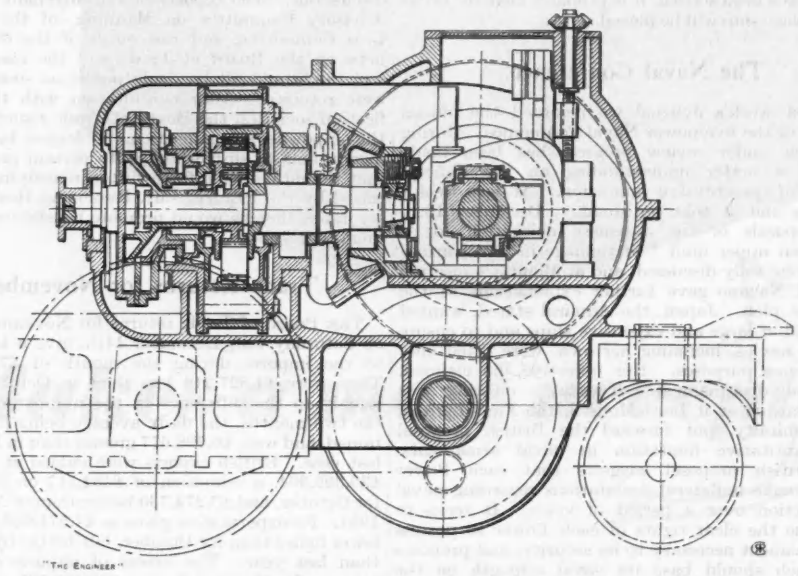


FIG. 2—SECTION THROUGH EPICYCLIC GEAR

The gearing underwent experimental tests at Beardmore's works, and we publish the report of these tests almost in full and only with such alterations as are necessary to make it suit our columns.

REPORT OF TESTS, 1926.

It was decided to construct the epicyclic gear as it would be when fitted to the locomotive, but omitting two clutches which form the intermediate gear, and to carry out the tests with the existing experimental vee-type two-cylinder 16in. bore by 18in. stroke crude oil engine developing 350 b.h.p. at 375 r.p.m.

In order to try out the clutch plates at the normal working load, the number of plates in the clutches was reduced proportional to the b.h.p. of the two-cylinder test engine and the eight-cylinder locomotive engine.

DESCRIPTION OF GEAR.

Epicyclic Gear.—The epicyclic gear is of the simple type, consisting of seven gear wheels, which are controlled by hydraulically operated friction clutches, in order to obtain two speeds and a free engine. Two clutches are provided, one for the low speed and one for the through drive, the frictional surfaces consisting of special bonded asbestos facings. By the addition of two more clutches, an intermediate gear is obtained.

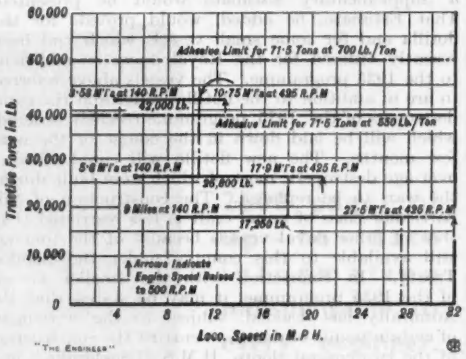


FIG. 3—TRACTIVE EFFORT CURVES

The existing gear is shown in Fig. 5, and consists of a centre gear or a "sun wheel," mounted on the driving shaft, which engages into five planetary pinions, each being mounted on separate spindles, which are secured to the driven shaft which normally carries the bevel pinion. These pinions engage into an internal ring or annulus, which carries the inner members of the driving clutch, and the abutment clutch, the latter of which encircles the annulus. This gear is arranged in its present form to give two speeds, one giving a reduction of 2·56 to 1, and the other a through drive.* The speed reduction of 2·56 to 1 is obtained by engaging the abutment clutch, thereby anchoring the annulus to the frame work. The through drive is obtained by releasing the abutment clutch and engaging the driving clutch. The clutches are operated hydraulically by applying pressure to annular

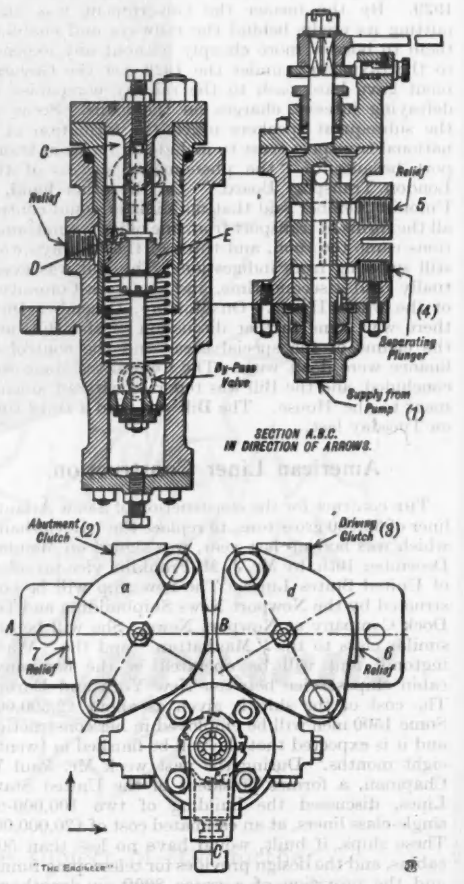


FIG. 4—CONTROL VALVE

* With the addition of two further clutches in the actual locomotive gear—Fig. 2—the speed ratio of 1·64 to 1 was obtained.

chambers, the fluid being transmitted to the through drive chamber by means of the gland, shown on the left in Fig. 5. There is also for the abutment clutch a series of plungers, which are hydraulically operated

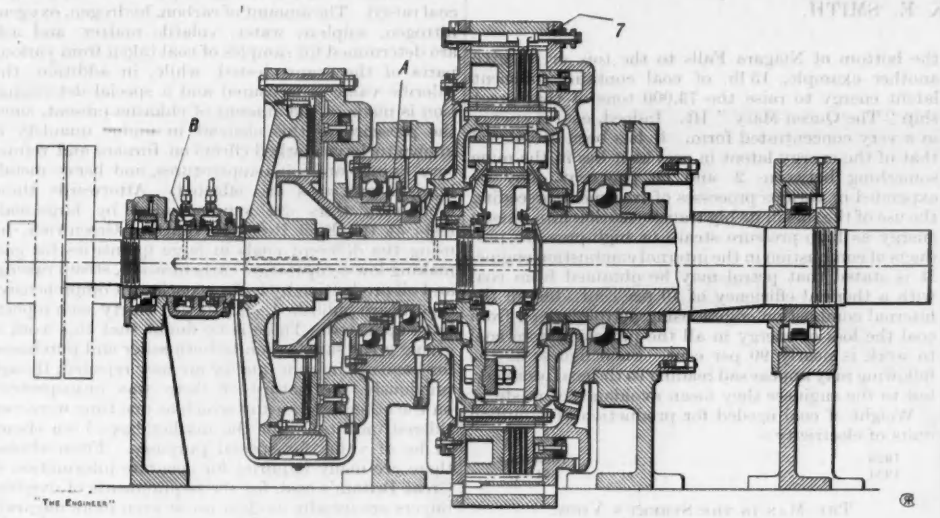


FIG. 5—ARRANGEMENT OF GEAR FOR TESTING

for separating the clutch plates to eliminate friction drag on the through drive.

The clutch operations are carried out by means of the control valve, referred to later. The pipe connections for coupling up the control valve to the clutches are illustrated in Fig. 6. Referring to this drawing, oil is sucked through the supply pipe to the oil pump, which forces it through the control valve to the clutches through pipes shown and also to the separating plungers through another pipe. These circuits are put into service or cut out according to the position of the operating handle on the control valve.

Control Valve.—The control valve is shown in Fig. 4, and consists of a valve with passages cut in such a way as to admit oil through the required ports to the clutches, also two piston valves and delay dashpots for delaying the time from applying the clutch pressure until the clutch plates finally grip. There is one piston valve and dashpot for the driving clutch, marked *d*, and a similar valve and dashpot for the abutment clutch marked *a*. The control handle is fitted with a ratchet device, so that the handle can only be moved in one direction. The spring release arrangement is arranged so that in case of necessity this could be withdrawn, and the valve turned in the opposite direction. The ratchet wheel is marked D, N, A, and S, and these positions when opposite the spring plunger denote the position of the control valve as follows:—

N, Neutral position.
A, Abutment clutch engaged.
S, Circuit open to separating plungers.
D, Driving clutch engaged.

The pipe connection 1 is coupled up to the pressure pump. Pipe connection 2 is connected to the abutment clutch; pipe connection 3 is coupled up to the driving clutch; pipe connection 4 is coupled up to the separating plungers; pipe connections, 5, 6, and 7 carry relief pipes to the tundish.

Oil Pumps.—A force pump of the gear type is provided for compressing the oil to about 100 lb. per square inch, for operating the clutches. This pump also contains a further set of gears for circulating the lubricating oil at a pressure of about 5 lb. per square inch to the working parts of the gear and to cool the clutches. This pump is separately driven from an electric motor at a speed of about 500 r.p.m.

Operation of Control Valve.—With the control handle set with the index N opposite the spring plunger, the control valve is set in the neutral position, and assuming that oil is being circulated from the force pump, it enters the passage 1 and passes through the control valve and out of passage 5, returning to the supply tank. If the handle is now moved so that index A is brought into line with the spring plunger, the circuit is opened for the abutment clutch, and the relief port 5 is cut off, passage 1 being then opened to the cylinder marked C. This cylinder contains a piston and liner, and in each is an adjacent port D. This port is so arranged that it is opened to relief when the piston is in its highest position, and when the cylinder is in connection with the clutch fluid annulus. The area of port D is smaller than that of the pipe, and so raises the oil pressure and forces the piston E downwards. This closes the port D, and correspondingly increases the pressure. The time occupied in closing this port is governed by the rate of transfer of the oil from the underside of the dashpot piston to the topside through the adjustable screw valve. This valve can be adjusted to delay this operation within certain limits. This same operation is brought into effect by moving the control handle to the pisition D for the driving clutch, but before turning to this position there is an intermediate position S which admits oil to the separating plungers and forces the plates to their off position.

Separating Plungers.—The separating plungers are for the purpose of separating the abutment clutch plates, and when pressure is applied the plungers, having extended spindles and forked ends, move the plates a predetermined distance, at the same time compressing the small springs 7 shown in Fig. 5. These springs have a restricted movement, which determines the amount of clearance between the clutch plates. After the pressure is released from the cylinders, these springs push back the plungers and clutch plates.

Lubricating Oil System.—The lay-out of the lubricating oil system is shown in the drawing,—Fig 7. Forced lubrication is used for all working parts of the epicyclic gear, Stern's "Diesel oil" being used, which is similar to that being used for the Speedwell type oil engines.

(To be continued.)

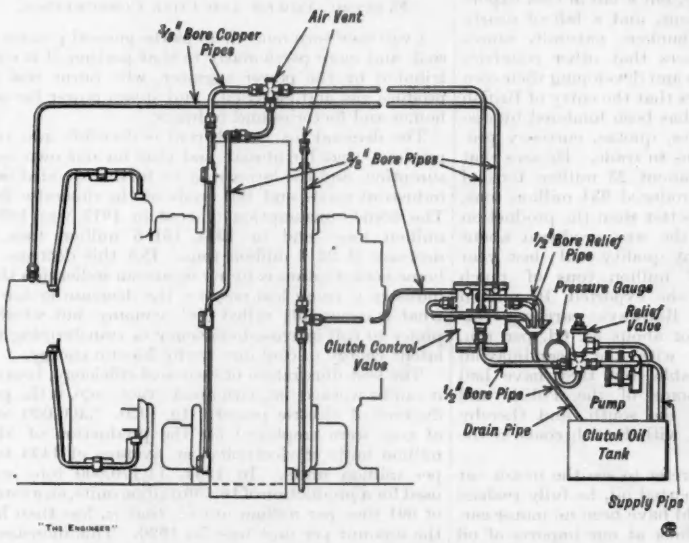


FIG. 6—PIPE CONNECTIONS BETWEEN CONTROL VALVE AND CLUTCHES

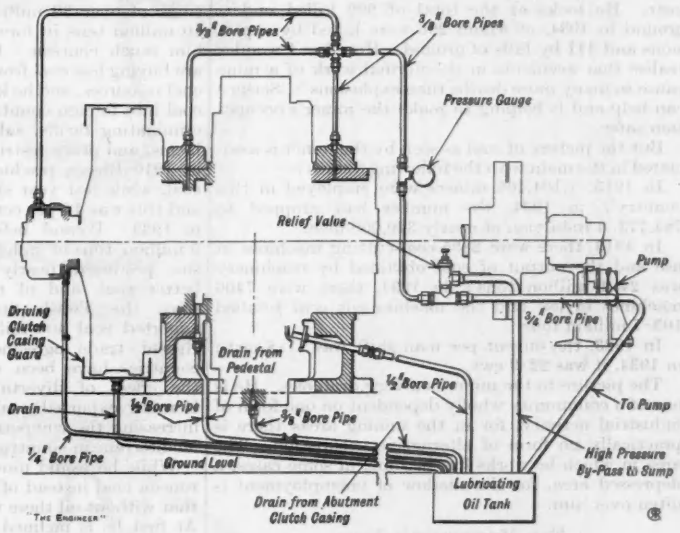


FIG. 7—LUBRICATING OIL SYSTEM

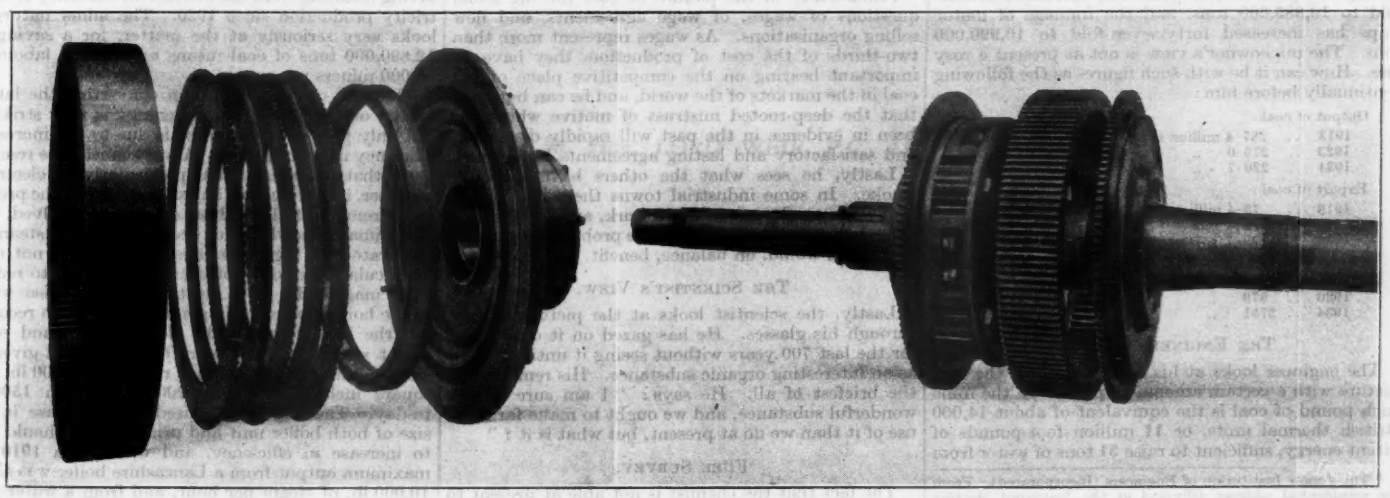


FIG. 8—SUB-ASSEMBLIES OF PARTS OF CLUTCH AND EPICYCLIC GEAR

Coal, Power and Smoke.*

By Sir FRANK E. SMITH.

INTRODUCTION.

THE words "Coal, Power and Smoke," which I have chosen as the title of this address, epitomise the industrial history of this country. They conjure to our minds also one of the most important of the industrial problems which face the nation, for the way in which we tackle this problem will affect in no small measure the industrial position Great Britain will hold among the nations in the future. Coal is the one natural raw material available to us in great quantity, or even vast quantities as measured by the scale upon which modern industry draws upon its raw materials. The winning of it has been and still is one of our greatest national industries, and its utilisation as a source of energy supplies the life-blood of most of British industry.

The picture I propose to put before you is not a simple outline; indeed, it is very complex, and the predominant tints are drab or rosy, according to the spectacles through which it is viewed, for while no doubt miner and mineowner see all of the picture at times, their attention is in general riveted to one particular part.

THE MINER'S VIEW.

Obviously the miner does not look upon coal through the spectacles of the mineowner or through those of an engineer. The winning of coal is, to him, a daily task, one without sunshine or even daylight to help him and so hazardous is his task that about one in every thousand of his kind is killed every year. He looks at the total of 999 killed underground in 1934, of whom 296 were killed by explosions and 441 by falls of ground. How few I wonder realise that accidents in the normal work of a mine cause so many more deaths than explosions? Science can help and is helping to make the miner's occupation safer.

But the picture of coal as seen by the miner is associated in the main with the following figures:—

In 1913, 1,104,406 miners were employed in this country; in 1934, the number had dropped to 784,773, a reduction of nearly 320,000 men.

In 1913, there were 2895 coal-cutting machines in use and the output of coal obtained by machinery was 24·4 million tons; in 1934, there were 7406 machines in use and the machine-cut coal totalled 103·7 million tons.

In 1923, the output per man shift was 17·8 cwt.; in 1934, it was 22·9 cwt.

The picture to the miner is a very drab one. He is one of a community wholly dependent on one form of industrial activity, for in the mining areas there is practically no form of alternative occupation. The area in which he works has become, in some cases, a depressed area, for the shadow of unemployment is often over him.

THE MINEOWNER'S VIEW.

Through the spectacles of the mineowner the predominant part of the picture is that of decreased demand and decreased profits. A diminution of output of 66 million tons since 1913 is most disquieting to him. In 1913, we exported 73 million tons and 21 million tons were used for foreign bunkers, a total of 94 million tons. In 1934, this total had dropped to 53 million tons, a fall of nearly 44 per cent. The mineowner looks with some alarm at the inroads of oil especially for marine purposes, and he knows only too well that war conditions led other countries to use more oil and to develop, where possible, their own coal resources and their water power.

In this country fuel oil has made but a slight inroad, the total amount at present used being a little less than 1 per cent. of the weight of coal used. On the other hand, the tonnage of oil-burning steamships during the past twenty years has increased fifteen-fold to 19,885,000 tons, and the tonnage of motor ships has increased forty-seven-fold to 10,990,000 tons. The mineowner's view is not at present a rosy one. How can it be with such figures as the following continually before him:—

Output of coal:

1913	287·4	million tons
1923	276·0	,, ,,
1934	220·7	,, ,,

Export of coal:			Foreign bunkers:		
1913	73·4	million tons	21·0	million tons	
1923	79·4	,, ,,	18·2	,,	,,
1934	39·7	,, ,,	13·4	,,	,,

Imports of petroleum oils:

1910	345	million gallons
1920	879	,, ,,
1934	2751	,, ,,

THE ENGINEER'S VIEW.

The engineer looks at his contribution to the coal picture with a certain amount of pride. In the mine each pound of coal is the equivalent of about 14,000 British thermal units, or 11 million foot-pounds of latent energy, sufficient to raise 31 tons of water from the bottom of Niagara Falls to the top, or, to give another example, 15 lb. of coal contains sufficient latent energy to raise the 73,000 tons of that great ship "The Queen Mary" 1ft. Indeed, coal is energy in a very concentrated form. It has been calculated that of the energy latent in coal as it lies in the mine something between 2 and 60 per cent. may be expended in various processes of treatment preceding the use of the fuel in its big transformation into kinetic energy as high-pressure steam or high-pressure products of combustion in the internal combustion engine. It is stated that petrol may be obtained from coal with a thermal efficiency of 40 per cent., but in the internal combustion engine using petrol derived from coal the loss of energy in all the processes from coal to work is nearly 90 per cent. Such figures as the following may appear sad reading to the coal producer, but to the engineer they mean avoidance of waste.

Weight of coal needed for production of 1 million units of electricity:—

1923	1083 tons
1934	661 ,,

THE MAN-IN-THE-STREET'S VIEW.

The man-in-the-street, looking at the picture of coal through his glasses is well pleased to see that we have in this country not less than 100 thousand million tons of coal in many and good varieties. The export of tens of millions of tons every year pleases him, for it enables him to pay for some of the food he must import in order to live, but a fall in that export trade of over 30 million tons, and a fall of nearly 10 million tons in foreign bunkers, naturally causes him much concern. He sees that other countries are buying less coal from us and developing their own coal resources, and he knows that the entry of British coal into foreign countries has been hindered by discriminating tariffs, subsidies, quotas, currency problems, and other restrictions to trade. He sees that in 1910 Russia produced about 23 million tons of coal, while last year she produced 93½ million tons, and this was 18 per cent. better than the production in 1933. Poland before the war produced about 5 million tons of indifferent quality coal; last year she produced nearly 29 million tons of much better coal, and of this she exported 10 million tons, the Polish State Railways carrying this exported coal 400 miles for about 3s. 6d. per ton. Recent trade agreements with the Scandinavian countries have been valuable, but they have had the effect of diverting some of the Polish and German exported coal to the south, and thereby increasing the competition with British coals in the Mediterranean countries.

While he would much prefer to see the motor car run on coal instead of imported oil, he fully realises that without oil there would have been no motor car. At first he is inclined to look at our imports of oil with very grave concern, for whereas when King George came to the throne we imported 345 million gallons of oil, last year the imports were 2751 million gallons, an increase of eight times in twenty-five years. These figures show that this country, which for many years produced at home all that was necessary for meeting its power requirements, was in 1934 importing power in the form of oil equivalent on a heat basis to 12 million tons of coal, and the quantity imported is increasing. However, being unbiased, the man-in-the-street listens to his oil friend, who tells him that while the 12 million tons of coal would have needed about 43,000 men to win it from the mine, the motor car industry employs, directly and indirectly, more than 1,000,000 persons, and incidentally Sir John Cadman has estimated that for every ton of motor spirit used here, 1 ton of coal is used for the purposes of motor vehicles and the motor industry.

Prominently in the picture he sees the big social questions of wages, of wage agreements, and new selling organisations. As wages represent more than two-thirds of the cost of production, they have an important bearing on the competitive place of our coal in the markets of the world, and he can but hope that the deep-rooted mistrust of motive which has been in evidence in the past will rapidly disappear, and satisfactory and lasting agreements be reached.

Lastly, he sees what the others have missed—smoke. In some industrial towns there is a saying that more smoke means more work, and the man-in-the-street wonders, if smoke were prohibited, whether the nation would, on balance, benefit.

THE SCIENTIST'S VIEW.

Lastly, the scientist looks at the picture of coal through his glasses. He has gazed on it on and off for the last 700 years without seeing it until recently as an interesting organic substance. His remarks are the briefest of all. He says: "I am sure it is a wonderful substance, and we ought to make far more use of it than we do at present, but what is it?"

FUEL SURVEY.

The fact that the chemist is not able at present to deliver the information we need, leads him to give us the next best thing, and that is the classification of all our coal seams according to their usefulness for processes which use coal.

A survey is being made by nine survey laboratories, the area embraced covering 96 per cent. of the total coal raised. The amount of carbon, hydrogen, oxygen, nitrogen, sulphur, water, volatile matter, and ash are determined for samples of coal taken from various parts of the seams tested, while, in addition, the calorific value is measured and a special determination is made of the amount of chlorine present, since the presence of this element in undue quantity is known to have marked effects on furnace and refractory linings at high temperatures, and hence metallurgical processes are effected. Afterwards these laboratory tests are supplemented by large-scale tests at the Fuel Research Station, Greenwich, by using the different coals in large quantities for gas-making low-temperature carbonisation, steam raising, and oil production by hydrogenation. Comprehensive reports are published, and already thirty such reports have appeared. There is no doubt that this work is giving great satisfaction to both seller and purchaser, for bands of inferior quality are now rejected, though previously the nature of them was unsuspected; on the other hand, seams which at one time were considered unsuitable for the market have been shown to be of value for special purposes. From abroad there are many inquiries for accurate information of Great Britain's coal, for the requirements of overseas buyers are usually as clear as, or even more narrowly defined than, those of home consumers. The survey has shown that there are no technical difficulties in meeting most requirements, for there are very few foreign coals having characteristics which cannot be matched by British coal, and there are many British coals not easily matched abroad.

ELECTRIC POWER AND COAL CONSUMPTION.

I will now turn once more to the general picture of coal, and more particularly to that portion of it contributed by the power engineer, who burns coal to produce gas and electricity and steam power for our homes and factories and railways.

The demand for British coal is divisible into two portions, that for abroad and that for our own consumption, and the latter may be further divided into industrial needs and the needs of the domestic fire. The home consumption of coal in 1913 was 183·9 million tons, and in 1934 161·5 million tons, a decrease of 22·4 million tons. But this decrease in home consumption is by no means an indication that industry is using less power; the decrease is due to what is commonly called fuel economy, but which I prefer to call increased efficiency in transforming the latent energy of coal into useful kinetic energy.

The best illustration of increased efficiency, because it can be worked out with great exactitude, is the production of electric power. In 1920, 7,360,000 tons of coal were employed for the production of 5167 million units of electricity, an average of 1424 tons per million units. In 1934, 11,170,000 tons were used for a production of 16,896 million units, an average of 661 tons per million units; that is, less than half the amount per unit used in 1920. This increase in efficiency is perhaps more striking if I put it in a slightly different way, and say that had the engineer produced no improvement in method since 1920 the production of the electricity used in 1934 would have needed 24,060,000 tons of coal, or 12,890,000 tons of coal more than were in fact required.

This increase in the efficiency of electricity production is perhaps seen in a better perspective if we compare it for a moment with one aspect of the increasing use of oil fuels.

In 1934, we imported a record quantity for any one year of 8,436,000 tons of motor spirit and the various types of fuel oil, of which 4,178,000 tons were motor spirit. If we assume that 1 ton of the mixed oils is equal in energy to 1·4 tons of coal, and that we can regard the oil as replacing on this basis an equivalent quantity of coal, then the whole of the replacement represented by last year's imports is still less than the saving resulting from the increase in efficiency of electricity production since 1920. The miner naturally looks very seriously at the matter, for a saving of 12,890,000 tons of coal means a saving in labour of 46,000 miners per annum.

This feat of the engineer in converting the latent energy of coal into electrical energy is very striking, but only part of the increase is due to the increased efficiency in burning coal. Always must it be remembered that the engineer, and particularly the electrical engineer, is dealing with an exact science. The precise measurement of all the heat quantities involved, and an intimate knowledge of the properties of steam at moderate and high pressures, enables him not only to calculate the losses of energy, but often to reduce their magnitude. The heat needed to raise water to the boiling point is, in general, difficult to recover, but the heat given to the steam is not, and so in recent years more and more heat has been given to steam, and pressures have risen from 200 lb. per square inch in 1910 to 1200 lb. or even 1500 lb. to-day. The engineer realised that increase in the size of both boiler unit and prime mover should lead to increase in efficiency, and whereas in 1910 the maximum output from a Lancashire boiler was about 10,000 lb. of steam per hour, and from a water-tube boiler 20,000 lb. per hour, with efficiencies of about

* The Junior Institution of Engineers (Incorporated). From the presidential address delivered at the Inaugural Meeting at the Royal Society of Arts on Friday, December 13th, 1935.

The Rt. Hon. LORD WEIR, P.C., LL.D.

DRAWN FOR THE ENGINEER BY ELLIOTT & FRY

65 per cent., the unit size of water-tube boiler to-day has a capacity of over 1,000,000 lb. per hour and an efficiency of 90 per cent.

But the factor contributing most to the progress which has been made was the development of the Parsons steam turbine. There is, indeed, no greater epic in the whole history of mechanical engineering than this. The turbine has enabled the power which can be developed for a given weight of machinery in a given space to be increased a hundredfold. It has given power rotary motion at high speeds so desirable for electrical generators, and it has combined this advantage with great steam economy. It is true to say that the turbine has played a greater part than any other invention in rendering possible the wide-spread distribution of electrical power. Since 1920 the efficiency of production of electric power from coal has steadily risen, until to-day only 47 per cent. as much coal is needed per unit output as was required in 1920, and there are signs of still greater efficiency in the future. There are some who think that the figure of 661 tons of coal per million units output will not be appreciably diminished in the future but I would remind you that the figure of 661 tons is an average figure, and that some power stations have a much greater efficiency than the average. Indeed, the Battersea station, and, I believe, there is no other in the world more efficient, has a coal consumption as low as 407 tons per million units output. If all the generating stations in this country were equally efficient, there would be a total saving of coal of 17,000,000 tons on the basis of their coal consumption for 1920.

There is, however, still room for improvement, and fifty years hence electrical engineers may smile at our pride in having attained a thermal efficiency of 29 per cent., for even though it is a great achievement, that is all we have so far attained.

As the man-in-the-street looks at this part of the picture, he is naturally pleased, for it means more power is available, or, as I put it in my Gustave Canet Lecture, more mechanical slaves with no increase in cost. But to the miner and mineowner it represents an annual saving of nearly 13 million tons of coal and the labour of 44,000 men.

Shipping and Coal Consumption.

But let us look at another portion of the engineer's picture, this time one which is very prominent in the public eye. I refer to the fuelling of ships and the more economical running of the mercantile marine. The change from steam drive to motor drive and the raising of steam by oil burning instead of coal burning are dictated, as is well known, by economic considerations in the widest sense of the word, and it is a matter for regret to us as a coal-producing country that coal should for a time have lost its high position at sea. The substitution of oil for coal for the bunkering of so many ships is, indeed, one of the heaviest blows the coal industry has experienced, and one from which it cannot easily recover. In 1913, 21 million tons of coal were used as bunkers in ocean-going vessels, and in 1934 13·5 million tons were used, a decrease of 7·5 million tons. But the whole of this decrease is not due to the substitution of oil for coal. Quite a considerable part is due to the marked increase in efficiency in burning coal at sea, in the increased efficiency of the boilers, engines and propellers, and in the improved design of hull resulting in a diminution of sea and air resistance.

As a result of all these contributions we can safely say that the power required can be produced with a fuel consumption of 40 per cent. less than in 1913. Support of such an estimate is afforded by details of naval engineering given by Engineer Vice-Admiral Sir Harold A. Brown. In comparing a cruiser of 1935 with her predecessor of 1910, Sir Harold says: "Fuel demand as expressed in B.Th.U. required per shaft horse-power has been reduced by 40 per cent.; machinery weight per shaft horse-power reduced by 60 per cent.; machinery space per shaft horse-power by 60 per cent.; and engine-room complement per shaft horse-power reduced by 75 per cent."

Although this completes the story as far as the relation between fuel consumption and power production is concerned, there is another important aspect of which I ought perhaps to remind you. After all, the job of a cargo vessel is to carry cargo and not coal, and if the fuel necessary is reduced by, say, 40 per cent., it means that the ship need carry for a long voyage, say, to the Plate, only 1000 tons of coal instead of 1600 tons. As a result of this reduction there will be 600 more tons of deadweight available for freight-paying cargo on the outward voyage, and perhaps in the case we have taken 400 tons on the return voyage. The total effect, then, of improvements in efficiency is that not only is less coal required, but for the same amount of trade less ships are necessary.

I have told the story in terms of a coal-burning ship. The same conclusions apply, of course, in the case of a steamship burning oil.

If compared with their predecessors of 1910 all coal-burning ships of 1934 were more efficient by 40 per cent., then the 13·5 million tons of foreign bunker coal supplied in 1934 is less by 9 million tons than the amount that would have been required had there been no progress. However, the average increase of efficiency is no doubt less than 40 per cent., but I think an estimate of saving of 5 million tons is not excessive. It is well to remember that had it not been for the increase in efficiency of coal-burning plant, the replacement of coal by oil might have been more serious.

Railways and Coal Consumption.

In 1913 the railways of this country consumed 13,821,000 tons of coal and in 1934 12,170,000 tons. The decline of a little over 1½ million tons is undoubtedly due to two causes—increased efficiency in converting coal into useful work and decrease in trade. Since 1910 a big change in locomotive design has been brought about by the general introduction of superheating, by increasing steam pressures from 150 lb. to 300 lb., and by taking advantage of the latent heat of the exhaust steam which is no longer allowed to escape wastefully into the atmosphere. Sir Henry Fowler states that these changes have resulted in a saving of fuel of from 20 to 25 per cent. of the previous consumption (1910), whilst in addition there is about an equivalent saving of water. Such savings have allowed engines of the same weight being built so as to give increased capacity and power. The lower estimate of saving (*i.e.*, 20 per cent.) given by Sir Henry Fowler is equivalent to 3 million tons of coal. In his address to the Mineworkers' Federation of Great Britain, Mr. Joseph Jones, the President, said that "in 1919 the freight services on the American steam railroads used 170 lb. of coal per 1000 gross ton-miles. By 1931 the figure had been reduced to 119 lb." This is a reduction of 30 per cent. in the period 1919–31.

Gas and Iron and Steel Industries and Coal Consumption.

As with the other industries I have touched upon, so, too, in the gas industry, there have been marked changes during the past twenty-five years; changes which have led to increased efficiency and a marked reduction in the coal needed per cubic foot of gas produced. In 1910 the authorised gas undertakings in Great Britain produced 178,000 million cubic feet of gas and 15·1 million tons of coal were used; in 1934 the production was 295,300 million cubic feet, using 17·1 million tons. From these figures it will be seen that over 40 per cent. more gas can be produced per ton of coal to-day than was produced in 1910. The thermal value per cubic foot is not constant, but there is little doubt that if the efficiency to-day was only of the standard of 1910 an increased use of about 8 million tons of coal would be needed for the present output.

Iron and Steel and Coal Saving.—The demands on the coke oven industry rise and fall with the demands on the iron and steel industry and the coal distilled by the former may be regarded as being consumed by the latter. The average annual consumption of coal in the iron and steel industry during 1922–3–4 was 22·5 million tons, and during the three years 1932–3–4 it was 10·7 million tons. The production of cast iron and steel averaged 14·1 million tons in the former period and 11·6 million in the latter, but the proportion of steel was less in 1932–3–4. An increase in efficiency is, however, obvious, and the British Iron and Steel Federation claim that compared with 1923, largely from the application of the results of research, £4,500,000 is saved per annum in the cost of fuel. If the coal used by the iron and steel industry costs 15s. per ton, £4,500,000 represents a saving of about 6 million tons of coal per annum.

Saving of Coal.—Thus in the five big coal-using industries, the results of applied research during the reign of King George have effected economies in the use of coal of the order of 35 million tons per annum, made up as follows:—

Electricity undertakings	13 million tons
Shipping industry	5 " "
Railways	3 " "
Gas industry	8 " "
Iron and steel industry	6 " "
	35 " "

Products of Coal Distillation.—Let us for a moment go back to the coal distillates. The products given in Professor Morgan's table are, indeed, wonderful in variety, and we know how from coal tar all sorts of useful things, from medicines to wood preservatives, are obtained. I am certain that intensive research will make these tars, and therefore coal, a much more valuable commodity than it is to-day, but for the present only a small percentage of coal tar is used for chemical purposes. Some of the tar is distilled to produce some motor spirit, but the bulk—and it is a considerable bulk, for 1,764,000 tons of coal tar were produced in 1934—is used for other purposes, such as in the surfacing of roads. The need to-day is for the means to produce new and valuable materials from the tar constituents, and research alone is likely to produce results of value. But while researches are going on there are two known ways of converting coal tar into commodities for which there is a great demand; the one is to process it for fuel oil or for use in Diesel engines, and the other is to hydrogenate it for the production of motor spirit.

Hydrogenation.—To the man-in-the-street the problem of converting coal tar and coal into petrol appears at times easy and at other times very difficult. To the chemist, it is a problem of converting those complex benzenoid and other structures in coal into simpler structures containing a greater proportion of hydrogen. By much research it has been shown that the whole of low-temperature tar, *i.e.*, that produced up to about 700 deg. Cent., and a large part of all tar, can be converted into motor spirit by treatment with hydrogen at a pressure of 200 atmospheres and a temperature of 450 deg. Cent., a catalyst such as molybdenum sulphide being employed. In our ignorance we can but imagine that the catalyst helps to break down one structure and build up another. By a similar treatment, coal can be converted into oil and motor spirit. The coal is pulverised and mixed with oil or tar, and this mixture, on first treatment in the plant, is converted into a heavy oil, which is further treated to produce motor spirit. This process has aroused very much public interest, for it enables us to produce something which is not a natural product of the country and which is needed in certain industries, such as the aircraft industry, which are essential to national defence. The large-scale plant at Billingham can be arranged to give fuel oil, Diesel oil, petrol, and liquefiable hydrocarbon gases, such as propane and butane. Its capacity is 150,000 tons of petrol per annum, equivalent to about 4 per cent. of our consumption of motor spirit. The extra coal consumption corresponds to the employment of 2000 miners. In addition, about 1000 men are employed on the plant and another 1000 on extended services.

At present development is largely on an empirical basis, and it may be that very rapid progress will be impossible until we know more of the chemical structure of coal and the exact nature of the chemical reactions which take place.

Another process, due to Fischer, is also being developed in Germany to produce motor spirit. In this liquid hydrocarbons are produced from a mixture of carbon monoxide and hydrogen in the proportion of two parts of hydrogen to one of carbon monoxide. At a particular temperature, about 190 deg. Cent.—the correct temperature is essential to the reaction—these gases combine together at atmospheric pressure provided another substance is present to act as a catalyst. The catalyst apparently must contain cobalt or iron. The mixture of carbon monoxide and hydrogen is, of course, what is usually called water-gas, and is obtained by passing steam over coke or powdered coal. By this process it is theoretically possible to obtain 70–80 per cent. of the calorific value of water-gas as hydrocarbons, but in practice the yield of liquid product is about half this theoretical value. The anti-detonating value of the products suitable for motor spirit is somewhat low, but this can be increased in many ways; for example, by the addition of a small amount of tetraethyl lead. There is also a yield of lubricating oil, very good Diesel fuel, and of paraffin, which can be used in the manufacture of candles, and, because of its high purity, in the manufacture of fatty acids. The paraffin also has good dielectric properties.

Needless to say, this process, which is very attractive because it can be carried out without high-pressure equipment, is being carefully watched in this country. One essential to the satisfactory running of the process is that the gases must be free from sulphur, which causes the activity of the catalyst to deteriorate, or "poisons the catalyst," as it is put.

It is as obvious to the man-in-the-street as to the miner and mineowner that hydrogenation, being a new industry, must increase the demand for coal. It is equally obvious that this portion of our picture of coal could not have been brought into existence without the aid of the research scientist. But the mere production of petrol from coal is not a completely satisfactory solution to the problem of obtaining a fuel for the internal combustion engine. A possible development is the use of finely pulverised coal in the Diesel engine. Experiments on a fairly large scale are being made, and while the technical difficulties are great, they are by no means insuperable. The production of high-grade lubricating oils from coal is another part of the picture which the research worker is endeavouring to produce. Indeed, science is not only lessening the demand for coal by increasing the efficiency of processes in which coal is used, but is planning also new industries to use more coal and to produce products, some of which we import from abroad and others which hitherto have never been produced, but, once realised, will probably lead to an increase in the amenities of life.

Smoke.

When looking at the general picture of coal through the glasses of various types of individuals, I did not invite the foreigner to express his views. Had I done so, he would have seen, as he always does, the smoky atmosphere of our industrial towns and their suburbs. We cannot look upon smoke but as an evil which, in the interests of the community as a whole, should be abolished. In their interim report the Newton Committee suggest that the domestic chimney is responsible for at least half of the pollution. That this estimate is conservative is suggested by measurements by Dr. J. S. Owens, who found that in London the pollution consisted roughly of 2½ parts domestic and 1 part industrial smoke, and in Glasgow 3½ parts domestic and 1 industrial. It appears, therefore, that greatest progress is to be expected by an attempt to limit domestic pollution,

especially as the pollution from the average domestic chimney, containing, as it does, a larger proportion of tarry matter, is the more injurious.

Industrial plants, in some cases no doubt because of a present-day appreciation of the waste due to incomplete combustion of fuel, offend far less now than formerly. At the Battersea power station smoke is absolutely prevented, and sulphur pollution is reduced to a negligible amount. Maybe the station would be even more efficient in terms of coal per unit output of electricity if it did not clean its flue gases. I do not know. At present, however, there is no more efficient power station in the world. And what Battersea can do, other large power stations and large industrial units can also do.

With regard to the domestic fire, the obvious remedy is to devise grates that will burn coal more efficiently, or to substitute smokeless fuels, such as low-temperature coke, gas coke, anthracite, gas, or electricity. The path to our smokeless goal is not, however, an easy one. But when we realise the damage done to health and property, it does at least seem worth while to endeavour to reach the goal in our own lifetime.

Conclusion.

Having surveyed from various aspects the more interesting portions of the picture painted by the old and modern masters of coal, it is of interest to ask, What will be added to the picture in the future ?

To me it appears certain that industry will not only continue to burn coal, but will strive and succeed in burning it much more efficiently than is done to-day. This means less coal per unit of output, but such output should be larger, and the benefit to the community should be even greater than at present. Because we have vast resources of coal is no good reason why we should waste them.

Science will, I believe, gain increased knowledge of the chemical structure of coal and of the various reactions which ensue when coal, or a part of it, is burnt volatilised, or dissolved. This will lead to improvements in existing methods of using coal, and will also lead to methods for obtaining products which at present do not exist. The production of liquid fuels should be cheaper, and no doubt lubricating oils will be made. It is well to remember that the motor industry, the aircraft industry, the rayon industry, the radio industry, the artificial nitrates industry, and the hydrogenation of coal are all new in our own lifetime—at least, they are in mine—and they employ well over a million workers. Why not be optimistic and see in the picture of coal's future the use of de-ashed pulverised coal in internal combustion engines and new industries that science will produce with coal as the raw material. And one can but hope that at least some of these new industries will find a home in the present depressed areas, and that with such alternative occupation the shadow of unemployment will gradually disappear.

The Standard-Sunbury Engine Indicator.

By E. S. L. BEALE and R. STANSFIELD.

No. II.

(Continued from page 619, December 13th.)

TYPICAL indicator diagrams are given in figures which follow. It will be noted that the diagrams of rates of pressure change in the engine cylinder indicator diagrams—Figs. 7 and 15—show much more clearly than the orthodox diagrams the moment of start of combustion, and, in the case of the petrol engine, of detonation. Similarly, the diagram of fuel valve velocity—Fig. 8—shows very clearly the moment of valve opening, and those who have used the indicator for general testing are rapidly becoming accustomed to thinking in terms of rates of change, reserving use of the direct diagrams for the survey of general changes due to alteration of engine conditions.

Typical Indicator Diagrams.

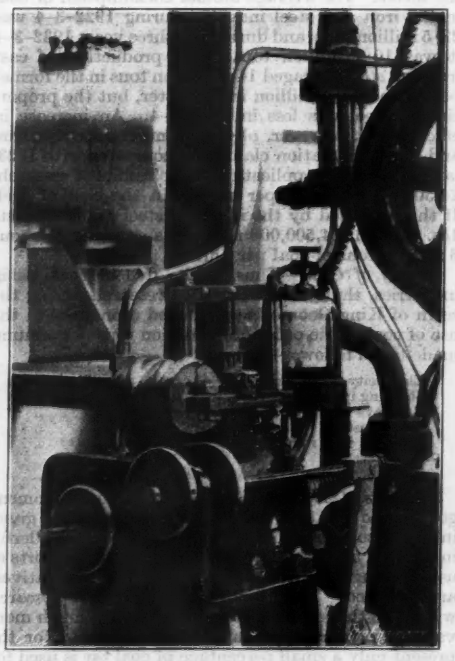
(*a*) *Degree Base.*—The diagram—Fig. 16—shows part of a degree scale on a spread base, the smallest serrations being spaced by 2 deg. of crank angle. This scale is switched on to the screen of the oscillograph to determine the timing of any event in the engine cycle.

(*b*) *Cylinder Pressure Diagrams from Diesel Engine.*—Fig. 4 is the pressure diagram from the cylinder of a Diesel engine running at 900 r.p.m. A moderate spread of diagram is shown, but this may be increased by the amplifier controls, so that the 10 deg. distances exceed the full screen width at this engine speed, or it may be decreased so that the entire cycle becomes visible with the exception of the small amount necessary for good contact breaker operation during which no diagram is drawn. The use of a Thyratron controlled sweep eliminates all but a negligible part of a small missing section of the diagram unavoidable with a mechanical contact breaker control. The Thyratron is operated from a simple magnetic pick-up connected to the grid and excited by means of a rotary armature on the engine crankshaft. Its use is hardly justifiable for most purposes since the missing part of the diagrams obtained with the mechanical sweep control can readily be phased on to the screen when required.

A contracted cylinder pressure diagram is shown in Fig. 5.

Reverting to Fig. 4, note the easy beginning of combustion from the compression line 2, followed by an increasingly rapid rate of pressure rise 3, and then by a falling rate of rise until the peak of the diagram 4 is reached. The dotted line is taken from a low-ignition quality fuel. The combustion starts later than on the better fuel, though the moment of injection is unaltered, and the maximum rate of pressure rise is much greater than in the case of the high-ignition quality fuel. This greater rate of pressure rise leads to more shock to working parts, and is the cause of the increased " Diesel shock " associated with low-ignition quality fuels. It is also found that starting difficulties are more prevalent with low than with high-ignition quality fuel.

(*c*) *Spray Valve Diagrams.*—In order to compare the ignition qualities of various fuels, tests are made to measure the delay angle between the moment of opening of the spray valve and the beginning of combustion under controlled running conditions in a suitable engine. For such measurements, it is necessary to indicate the spray valve lift, and Fig. 6 shows a valve lift diagram taken at an engine speed of about 600 r.p.m. and at low load. The maximum possible lift of this valve is 0·0135in., but it only reaches the stop at much higher loads and speeds than those at which the diagram was taken. Observation of spray valve behaviour during acceleration and deceleration runs of an engine often shows that there are several critical combinations of load and speed at which the point of valve opening may jump erratically from cycle to cycle by several degrees of crank angle; sometimes the valve may lift, reseat, and then lift a second time, and the longer opening period may be either the first or the second of the pair. During acceleration at full pump stroke from low



INDICATING UNIT FOR LIFT OF FUEL PUMP DELIVERY VALVE

speed there may be as many as five or six waves in the lift diagram, and the maximum lift may be reached either very early or only towards the end of the period of opening. Change from a fuel of normal viscosity to one of low viscosity may either retard or advance the injection timing by a few degrees depending on the characteristics of the entire fuel system. It is thus possible for a certain fuel to be replaced by another which has an equally good ignition quality, but which, on account of the different viscosity, gives trouble. If the viscosity change results in a later opening of the spray valve, then burning starts later, and, in an extreme case, higher mean temperatures may result with poorer efficiency, more rapid carbonisation of spray valves, and generally inferior performance. The cure in such instances is, of course, an alteration to fuel pump timing to compensate for the altered viscosity effects.

(*d*) *Velocity Diagrams of Change of Cylinder Pressure and Spray Valve Lift.*—It will be noticed that determination of the precise point of opening of the spray valve is a little difficult on account of the easy curvature of the beginning of the lift curve. The difficulty is similar to that experienced in the determination of the precise point of beginning of combustion. One of the most important advantages of the velocity diagram (from the point of view of fuel testing) lies in the fact that this diagram, the first differential of the orthodox pressure or lift diagram, shows so much more clearly the positions where contraflexure occurs. Fig. 7 is the diagram of rate of change of cylinder pressure corresponding to Fig. 4, and is obtained merely by switching one of the amplifier controls of the indicator. Positive rates of change are below and negative rates above the almost horizontal line intersecting the diagram. The degree base with 10 deg. intervals is drawn below the diagram; 1 corresponds to the point in the compression line of Fig. 4, where the compression pressure is rising at its maximum rate; 2 shows the moment of beginning of combustion in both diagrams, easily detected in the velocity diagram, but not precise in the ordinary pressure card; 3 gives the maximum rate of pressure rise during the rapid and uncontrolled combustion, and is a measure of shock; 4, a position of no rate of change of pressure, is the position of maximum pressure; while 5 gives the maximum rate of pressure fall during expansion. The dotted line on Fig. 7 shows very clearly the differences introduced by a low-ignition quality fuel. The beginning of combustion occurs when the compression pressure has begun to fall and is about 4 deg. later than for the high-quality fuel. The maximum rate of pressure rise leading to shock is about twice as great as for the better fuel. Vibratory effects may be observed at times, although for clarity these have been smoothed out of the figure reproduced. There is no difficulty in measuring the time of the beginning of combustion on a smooth running fuel in a high-speed engine to within a quarter of a degree of crank angle with a velocity diagram of this type.

A diagram of the velocity of spray valve lift is given in Fig. 8. This was taken under different engine running conditions from those for Fig. 6 and the valve does not partly reseat. The clear indication of the opening point will be noticed and also the vibrations near the closing point on the right of the diagram, where the valve assembly vibrates as the rapidly closing needle strikes and squeezes out the oil film on the seating.

Measurements of delay angle can be made far more accurately by means of such velocity diagrams than has hitherto been possible, and their value for measuring relative rates of cylinder pressure rise is obvious.

(*e*) *Fuel System Pressures.*—Fig. 9 is a pressure diagram from the fuel pipe of the same engine taken at a point in the system close to the spray valve. Note the first wave of pressure produced at the pump and while the plunger is over-running the suction port. The serrated horizontal part of the pressure record at a pressure of about 80 atmospheres occurs just before the beginning of effective opening of the spray valve and the closing of the valve comes just beyond the last well-defined peak on the right. In this example the valve operation is critical and a small change in fuel viscosity will alter the opening point by several degrees of crank angle.

The surge of pressure about 70 deg. after top centre is due to a shock wave set up by rapid flow of fuel through the pump suction port when this is opened on the downstroke of the plunger, a partial vacuum having been created in the pump barrel during the later part of the downstroke.

Fuel system pressure diagrams taken at the pump end show higher pressures by amounts depending on both the pipe length and size, and the viscosity of the fuel used, and the wave forms are displaced to the left by the speed of sound in the length of pipe between the respective positions of the indicating units.

(*f*) *Application to Enclosed Valves and other Special Cases.*—The engraving shows an experimental indicating unit applied for measuring the lift of the fuel pump delivery valve. It consists of a powerful horse-shoe electro-magnet having pole pieces which can be nipped against a pipe wall. The energising coil is in front just above the control screws of the fuel pump. A coil from a telephone receiver earpiece is mounted on each of the poles of the magnet. The steel union above the delivery valve of the pump has been replaced by a union of phosphor-bronze of standard internal dimensions with two horizontal slots filed outside into which the magnet poles are tightened, by means of a right and left-hand threaded straining screw. The steel delivery valve spring has been replaced by a bronze spring having the same rate and initial load, and bearing on a thin steel disc fastened to the head of the delivery valve. This disc is coupled to a light steel extension rod projecting upwards inside the coils of the valve spring. The magnet poles are so arranged that the upper end of this steel extension rod is in line with the poles when the valve is at the top of its lift. The diagram of valve lift is shown in Fig. 10. The slightly flattened top coincides with that part of the lift during which the cylindrical

extension below the valve seat is clear of the cylindrical bore. The diagram is interesting mainly because it illustrates the extreme adaptability of the magnetic system of indicating when used in conjunction with an amplifier having an integrating stage. It was also found that the valve lifted at an almost constant position in terms of crankshaft angle, but remained open for an almost constant time over a very wide range of engine speed.

Radial deflections and vibrations, &c., may be indicated by suitably supporting an electro-magnetic indicating unit close to the shaft circumference, while inlet and exhaust valve behaviour has been studied by fitting a tapered conical spring cap and applying two units at opposite sides of the cap, the integrated output on the tube screen giving lift diagrams.

(*g*) *Weak Spring Diagrams.*—Weak spring diagrams have hitherto always been a source of difficulty, both for cylinder pressures and for parts of the system external to the cylinder proper. Cylinder weak spring diagrams may be obtained in two ways. If the air gap between the magnet and diaphragm is very much reduced from that required for a normal pressure record the card becomes so large that a weak spring diagram is obtained and the high-pressure portions are completely off the screen. This method is limited to cases where the maximum rate of change potential in the search coil of the indicating unit can be kept below the value at which the first valve stage of the amplifier becomes overloaded. An alternative and better method is to use a thinner diaphragm in the unit and to adjust the air gap so that the higher cylinder pressures close the gap, the pole of the indicating unit acting as a limit stop. A weak spring diagram on open scale may readily be obtained in this way, the high-pressure portions of the diagram being meaningless.

Small pressure changes in suction pipes, exhaust pipes, scavenge systems of two-stroke engines, &c., are best indicated with a cylinder pressure unit in which the normal 30/1000in. thick diaphragm is replaced with a diaphragm about 7/1000in. thick. Such a diaphragm has a natural frequency of about 10,000 cycles per second and a short flexible connection between the engine and the unit may be of help to eliminate small effects due to mechanical vibrations. A scale of 1in. to 1 lb. per square inch can easily be obtained with this type of unit.

Fig. 11 shows a diagram of the pressure changes in the suction pipe of a four-stroke engine taken near to the inlet port. The inlet pipe was about 2ft. 6in. long and the engine speed 900 r.p.m. The opening to suction involves acceleration of the air column in the suction pipe and the consequent negative pressure is shown by the large downward wave on the diagram. The pressure then rises almost to atmospheric, falls a little as the piston reaches maximum velocity, and then rises above atmospheric towards the end of the suction stroke as the moving air column in the pipe is arrested. When the suction valve closes the air in the pipe is set in vibration at the natural frequency due to the pipe length, the amplitude falling slowly with frictional damping until the next suction stroke starts.

Fig. 12 shows the same type of diagram taken with about half the suction pipe removed. The negative pressure immediately after the opening of the valve and the later supercharge are reduced owing to the smaller air mass to be accelerated and retarded, the frequency of natural oscillation is doubled and the total damping is increased. Fig. 13 is taken with the full length of pipe, but with two small slots left open at the joint between the halves of the pipe length. Air flow from these slots to atmosphere during periods when a high-pressure part of the wave passes and air flow inwards during the transit of low-pressure periods applies a pronounced frictional damping, only one marked vibration occurring before the pressure becomes stable.

(*h*) *Detonation in Petrol Engines.*—Figs. 14 and 15 are diagrams taken from the cylinder of a petrol engine and serve to illustrate once more the advantages of the velocity diagram.

Fig. 14 (full line) is the pressure card from an engine running under detonating conditions with heavy knock. The point of ignition was picked up electrostatically by the indicator without special connections. Detonation does not start until slightly after top centre, although the knock was heavy, and the rapid pressure rise takes place in only two to three degrees of crank angle being followed by pressure changes at a relatively high frequency and also by a small further rise of pressure. The smooth running diagram obtained after changing to a fuel of much higher octane number is shown by a dotted line.

The first part of the corresponding velocity diagram (or rate of pressure rise) is shown in Fig. 15 in full lines, positive rates of change of pressure being below the base line. Note the waves of very small amplitude just before the detonation starts. These have a frequency which agrees in order with that expected from the short length of indicator passage and they afford a means for correcting for the phase lag due to the passage, a correction of one-quarter of the wave length being necessary.

Detonation produces a vibration of high amplitude at the frequency of a sound wave backwards and forwards in the engine cylinder. The first eight periods

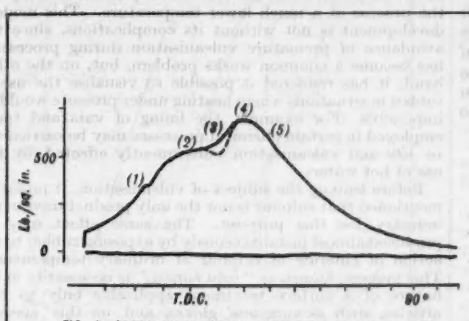


FIG. 4. PRESSURE DIAGRAM OF AN OIL ENGINE CYLINDER.

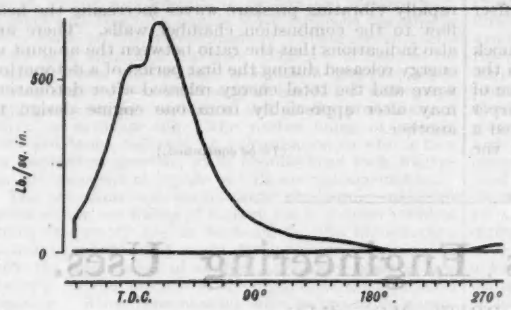


FIG. 5. CONTRACTED CYLINDER PRESSURE DIAGRAM.

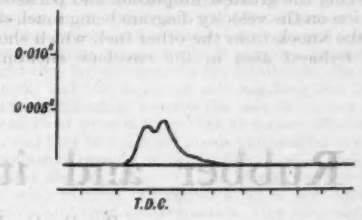


FIG. 6. SPRAY VALVE LIFT DIAGRAM.

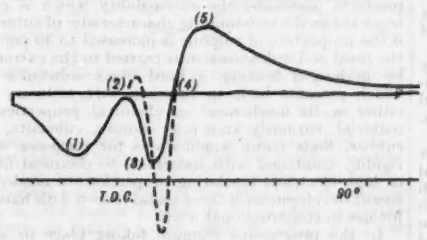


FIG. 7. DIAGRAM OF RATE OF CHANGE OF CYLINDER PRESSURE.

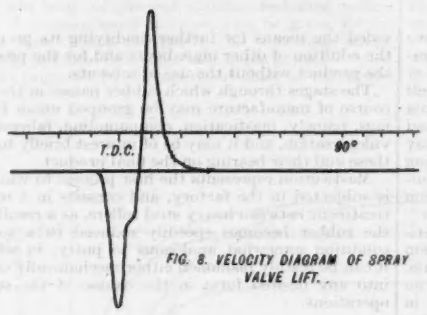


FIG. 8. VELOCITY DIAGRAM OF SPRAY VALVE LIFT.

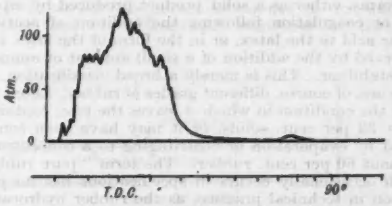


FIG. 9. PRESSURE DIAGRAM FROM THE FUEL PIPE OF THE ENGINE USED IN FIG. 8.

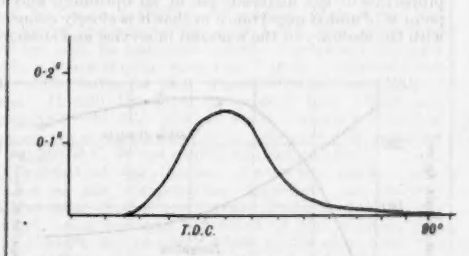


FIG 10. DIAGRAM OF LIFT

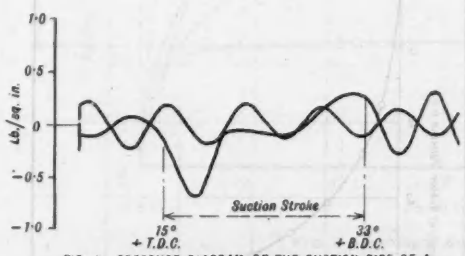


FIG. 11. PRESSURE DIAGRAM OF THE SUCTION PIPE OF A 4 STROKE ENGINE

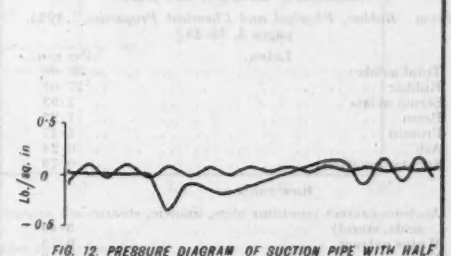


FIG. 12. PRESSURE DIAGRAM OF SUCTION PIPE WITH HALF SUCTION PIPE REMOVED

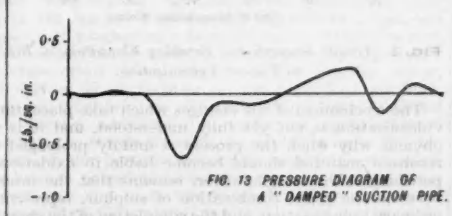


FIG. 13 PRESSURE DIAGRAM OF A "DAMPED" SUCTION PIPE.

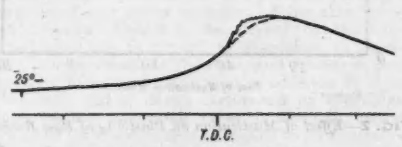


FIG. 14. PRESSURE DIAGRAM OF A PETROL ENGINE KNOCKING.

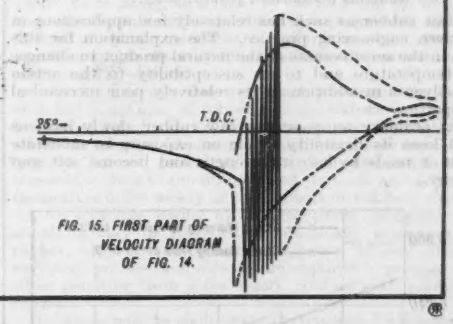
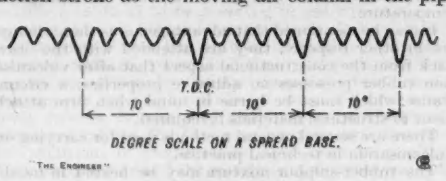


FIG. 15. FIRST PART OF VELOCITY DIAGRAM OF FIG. 14.



DEGREE SCALE ON A SPREAD BASE.

"THE ENGINEER"

FIG. 16

of this wave are shown followed by dotted lines giving the average envelope of the wave amplitudes. The chain dotted diagram was taken from a petrol of different chemical type. Note that the burning becomes slightly more rapid before detonation and that detonation starts earlier in the cycle, also that the amplitude of the vibrations is much less (shown by the chain dotted envelope). The two fuels indicated had precisely the same octane number measured by a bouncing pin indicator, the pin being used in the same position in the cylinder as the electrical indicator.

It appears that the bouncing pin indicator is operated mainly by occurrences just before and at the beginning of detonation, and that the subsequent history of the vibrations in the cylinder have no effect on its readings.

It is significant to observe that the audible knock from the two fuels was very different, that from the fuel giving the greatest amplitude and persistence of vibration on the velocity diagram being much sharper than the knock from the other fuel, which showed a much reduced area in the envelope enclosing the waves. Thus there is evidence that a knock measuring instrument similar to that developed by Professor Taylor, Mass. Inst. of Tech., which in effect measures the total vibratory rather than the initial pressure effects, is probably superior to the bouncing pin for knock testing purposes, always provided that it is used in conjunction with suitably modified engine conditions to correlate its indications with road behaviour.

The complete story of detonation phenomena can only follow much further research, but it may be added that there is some evidence from the heights of the mean lines of rates of change of pressure on different petrols that the loss of energy due to detonation occurs early in the cycle and it may be caused by the rapidly vibrating pressure waves increasing the heat flow to the combustion chamber walls. There are also indications that the ratio between the amount of energy released during the first period of a detonation wave and the total energy released after detonation may alter appreciably from one engine design to another.

(To be continued.)

Rubber and its Engineering Uses.

By B. D. PORRITT, M.Sc., F.I.C.,
Director of the Research Association of British Rubber Manufacturers.

RUBBER comes to the manufacturer in one of two forms, either as a solid product produced by separation or coagulation following the addition of acetic or formic acid to the latex, or in the form of the latex itself preserved by the addition of a small amount of ammonia as a stabiliser. This is merely a broad classification, and there are, of course, different grades of rubber. Latex may be in the condition in which it leaves the tree, containing about 33 per cent. solids, or it may have been concentrated by evaporation or centrifuging to a concentration of about 60 per cent. rubber. The term "pure rubber" which occasionally occurs in specifications has no justification in technical practice, as the rubber hydrocarbon is accompanied by small quantities of other constituents, such as resins, proteins, sugars, &c., which play an important rôle in its preservation from oxidation and in the processes through which it passes during the course of manufacture.

Constituents of Latex and Raw Rubber.

(From "Rubber, Physical and Chemical Properties," 1935, pages 3, 22–25.)

Latex.	Per cent.
Total solids	30·00
Rubber	27·07
Serum solids	2·93
Resin	1·22
Protein	1·47
Ash	0·24
Sugars (inverted)	0·79
Raw rubber.	
Acetone extract (contains oleic, linoleic, stearic acids, sterol)	3·40
Water extract	0·75
Nitrogen	0·49
Moisture	0·75
Ash (contains phosphates, potash, lime)	0·35

Raw rubber as such has relatively few applications in modern engineering practice. The explanation for this lies in the sensitiveness of the natural product to changes in temperature and to its susceptibility to the action of solvents in addition to its relatively poor mechanical properties.

At ordinary temperatures raw rubber slowly hardens and loses its flexibility, while on exposure to moderate heat it tends to lose its strength and become soft and sticky.

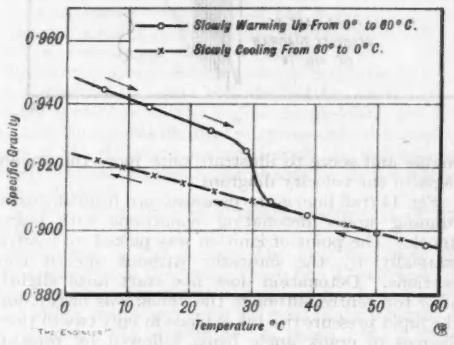


FIG. 1—*"Freezing" of Raw Rubber as shown by Specific Gravity Changes.*

If brought into contact with hydrocarbon oils it swells, becomes adhesive and finally dissolves, while if stretched to any appreciable extent it becomes permanently deformed.

For these reasons, prior to the discovery of vulcanisation in 1843, the uses of rubber were confined to the production of solutions for water and gas-proofing textile materials, and the pioneers of engineering probably viewed its possibilities as limited to such applications as diving dresses, and for its original application in the drawing-office for the removal of pencil marks.

The rubber industry as we know it to-day may be said to date from the time when chemical discovery yielded a tough elastic product relatively insensitive to temperature and solvents, and advances in mechanical science provided the means for further modifying its properties by the addition of other ingredients and for the processing of the product without the use of solvents.

The stages through which rubber passes in the ordinary course of manufacture may be grouped under four headings, namely, mastication, compounding, fabrication, and vulcanisation, and it may be of interest briefly to touch on these and their bearing on the final product.

Mastication represents the first process to which rubber is subjected in the factory, and consists in a mechanical treatment between heavy steel rollers, as a result of which the rubber becomes speedily reduced to a soft plastic condition somewhat analogous to putty, in which state it can be readily fashioned either mechanically or by hand into any desired form in the course of the subsequent operations.

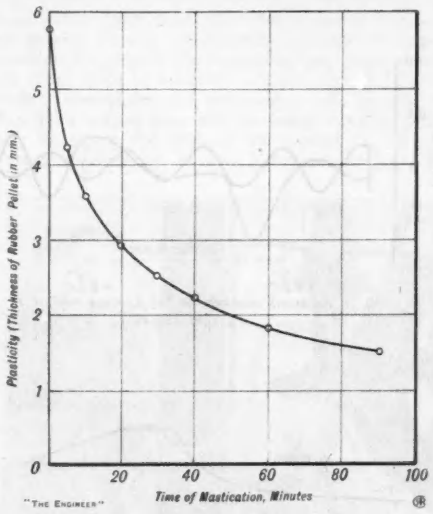


FIG. 2—*Effect of Mastication on Plasticity of Raw Rubber.*

But the plasticity and adhesiveness which facilitate the processes of fabrication are clearly the opposites of the properties desired in the final product, and this brings us to the subject of the changes brought about by the introduction of other ingredients into the rubber and the effect of the final process of vulcanisation.

Taking vulcanisation first, as being the more fundamental, it may be explained that, broadly speaking, this involves the addition of a small proportion of sulphur to the masticated rubber, and subjection of the product to an appropriate period of heating, when the original strength and elasticity is not only restored, but greatly enhanced, and the resultant material becomes insoluble in organic solvents and more resistant to changes in temperature.

It may be mentioned that advantageous as these changes are in other respects, they are attended with the drawback from the constructional aspect that after vulcanisation rubber possesses no adhesive properties, a circumstance which must be borne in mind when firm attachment to structural materials is required.

There are several general methods used for carrying out vulcanisation in technical practice.

The rubber-sulphur mixture may be heated in moulds or between heated platens of a hydraulic press, as, for example, in the preparation of packings and conveyor belting or the fabricated article—for example, hose and rubber-covered rollers—may be wrapped with cloth and exposed to live steam in an autoclave. Generally speaking, the rubber articles used by the engineer—known in the trade as "mechanicals"—are prepared by one or other of these methods, but occasionally a different procedure may be adopted, and some reference to alternative processes may be of interest, since it will bring in certain related developments which have vastly increased the productive output of the industry during recent years.

It has already been mentioned that the secondary natural ingredients present in raw rubber play a very important part in technical practice. When the action of those constituents which facilitate the remarkable and as yet imperfectly understood physical changes which take place during vulcanisation is further supplemented by the addition of certain inorganic and organic compounds, known as "accelerators," not merely can the time occupied in the process be reduced at will from hours to minutes, but it becomes no longer necessary to exclude the articles from contact with air which otherwise acts as an inhibitor. Articles, such as boots and shoes, for example, are generally vulcanised in hot air by what is known as the "dry heat" process.

The introduction of active organic accelerators, moreover, has not merely enabled the period of vulcanisation to be shortened, but it has rendered it possible to carry out the process at a much lower temperature. This modern development is not without its complications, since the avoidance of premature vulcanisation during processing has become a common works problem, but, on the other hand, it has rendered it possible to visualise the use of rubber in situations where heating under pressure would be impossible. For example, the lining of vats and tanks employed in certain chemical processes may be carried out *in situ* and vulcanisation subsequently effected by the use of hot water.

Before leaving the subject of vulcanisation, it might be mentioned that sulphur is not the only product used in the industry for this purpose. The same effect may be produced almost instantaneously by exposing rubber to the action of chloride of sulphur at ordinary temperatures. This process, known as "cold curing," is necessarily in the nature of a surface treatment applicable only to thin articles, such as surgeons' gloves, and on this account only calls for passing mention here. Mixtures in which the ratio of sulphur to rubber is relatively low and the period of vulcanisation comparatively short, yield final products possessing the extensibility which is generally regarded as the outstanding characteristic of rubber. But if the proportion of sulphur is increased to 30 per cent. of the total and vulcanisation is carried to the extreme limit by prolonged heating, a hard black substance results, which presents little in common with ordinary rubber, either in its mechanical or chemical properties. This material, variously known as ebonite, vulcanite, or hard rubber, finds many applications for purposes in which rigidity combined with resistance to chemical influences or high electrical insulating properties are needed, and a recent development is sheet metal coated with hard rubber for use in constructional work.

In the progressive changes taking place in a rubber sulphur mixing during the course of vulcanisation, it will be found that as the heat treatment proceeds the material will progressively become less extensible, while the breaking load will increase to a maximum and then fall off. There is therefore a stage at which the general physical properties of the material are at an optimum, and this point is of added importance in that it is closely connected with the stability of the material in service and storage.

FIG. 3—*Tensile Strength and Breaking Elongation in Relation to Time of Vulcanisation.*

The mechanism of the changes which take place during vulcanisation is not yet fully understood, and it is not obvious why when the process is unduly prolonged the resultant material should become liable to oxidation or perishing. The fact, however, remains that the interval between the slight combination of sulphur, representing ordinary vulcanisation, and the completion of the chemical reaction, resulting in the production of ebonite, is characterised by instability, and for this reason it is the custom in technical practice to adjust the vulcanisation of soft rubber goods on the safe side of the optimum physical properties.

Attention may now be directed to the general characteristics of the load-elongation curve for a material made from a "pure mix," that is to say, one containing only rubber and sulphur (see Fig. 4). It will be at once evident that rubber differs fundamentally in this respect from the metals and other materials obeying Hooke's Law, in which deformation is relatively small until the yield point is passed. With rubber the initial extensibility or compressibility are high and tend to diminish progressively as the load increases. At the breaking point a test specimen prepared from properly vulcanised material may show an elongation of 1000 per cent., and sustain a load in the neighbourhood of 150 kilos. per square centimetre (2100 lb. per square inch), a value which demonstrates that vulcanised rubber is not far removed from the metals in tenacity. To illustrate the improvement in physical properties effected by vulcanisation, it may be mentioned that the corresponding figures for a test specimen cut from a sample of the finest plantation smoked sheet would rupture at an elongation of about 500 per cent., and would not withstand a load exceeding 40 kilos. per square centimetre (550 lb. per square inch).

For many technical purposes, however, a high degree of extensibility and compressibility is not desirable and, indeed, may be disadvantageous. To appreciate this fact it is necessary only to recall the tough leathery material which is best suited for many forms of packing and the requirements of rubber flooring and tiling. It is a fortunate circumstance, therefore, that by the intro-

duction of other ingredients into rubber its physical characteristics may be varied to meet almost every practical requirement of constructional practice. Compounding ingredients, as these accessory materials are termed, may be roughly divided into three main groups, namely, pigments, fillers, and reinforcing ingredients, although it should be noted that there is no sharp line of demarcation between these; for example, a material used for a pigment at one time may serve as a reinforcing ingredient on another occasion.

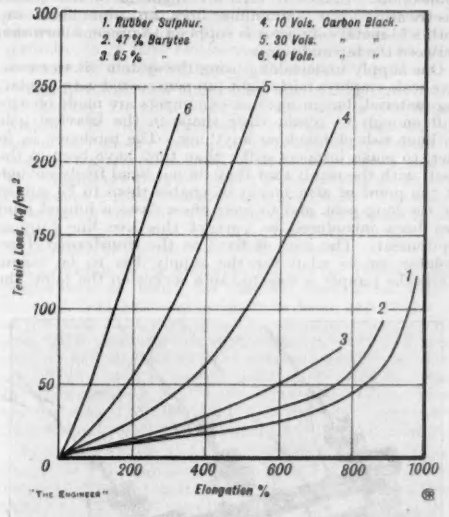


FIG. 4—*Effect of Compounding Ingredients on the Stress-Strain Curve.*

The effects produced by adding increasing proportions of ground natural barytes to a rubber sulphur mixing illustrate one result of compounding rubber. On testing the vulcanised products it will be found that the tensile strength is diminished almost in direct proportion to the quantity of barytes added, while the effect produced on the elongation is slight within comparatively wide limits. The density is, of course, increased and the percentage of rubber per unit volume diminished so that this particular mineral ingredient functions essentially as a diluent. It has, however, one important effect on the physical properties of the rubber to which attention must be drawn. During the mixing process and the subsequent manufacturing operations the crystalline particles tend to assume a definite orientation and give rise to a characteristic known as "grain" which renders the rubber liable to tear when subjected to localised stress. It will therefore be evident that compounds belonging to the filler class of which barytes is a typical example are suitable only for the production of materials not subjected to severe mechanical deformation.

If, instead of barytes, gas or acetylene black is substituted as the compounding ingredient, an entirely different state of affairs will arise. Instead of the tensile strength being lessened the effect of the addition will be to enhance this property while, at the same time, the deformability will be appreciably reduced. The result is a tough, strong material with marked resistance to cutting and tearing of the type familiarised by the qualities used for such purposes as tire treads, trawl bobbins, and the like.

The compounding ingredients which produce these effects are termed "reinforcing ingredients," and this property of toughening rubber shown by substances such as carbon black, zinc oxide, magnesia, and clay is probably a surface effect closely connected with the size, shape, and surface characteristics of the individual particles. There is, however, an optimum concentration beyond which further additions of a reinforcing ingredient tend to reduce the tensile strength, no doubt owing to the dispersion of the particles becoming imperfect, and when this limit is passed the resultant product begins to lose its resilience and to assume a tough, leathery character exemplified by the material now widely used for the soling of footwear.

It will be realised from this necessarily brief and superficial survey of the technique of the industry that the materials of which rubber forms the basis are infinite in their composition and properties. The manufacturer has at his disposal compounding ingredients ranging from gas black on the one hand to barytes on the other, each with its own specific properties. These may be used in varying proportions, either alone or in conjunction, and their effects may be still further modified by the presence of other ingredients designed to facilitate dispersion and vulcanisation or to enhance the stability of the final product. Moreover, fibres, textiles, and metals play an important part in this already complicated technique, and the function of rubber may be limited to acting as the bonding for asbestos fibre, or in the extreme case for the production of grinding wheels from emery and carborundum powder.

It is little wonder, therefore, that a material which may appear successively as an adhesive, an elastic thread a tire tread, a leather substitute, and a hard insulating material should find many and varied applications in the Arts. The field covered by engineering is almost equally difficult to define. Every industry has its own particular border line problems which need for their solution a knowledge of specialised plant design and the nature and properties of the appropriate constructional materials. To attempt to classify all these varied requirements would be an almost impossible task, and the only practicable method would seem to be to review some of the more important properties of rubber in relation to the general aspects of engineering practice.

Starting with the question of chemical resistance, it will be generally accepted that some of the most difficult problems in industrial practice arise in the construction and maintenance of plant for the handling of acid and alkaline liquors. The corrosive action of such solutions—particularly those containing hydrochloric acid—on unprotected metal, often results in the use of vitreous enamel or the substitution of glass, earthenware, or resinous wood for metal containers. The effect of steam and acid fumes on the general structure and equipment is, moreover, highly detrimental; for example, galvanised iron and leather belting can have but a short life under such conditions of service.

The resistance of rubber to alkalies and dilute acids and its indifference to humidity therefore become properties of great technical importance under such circumstances. It supplies hose and transmission belting which will withstand these severe conditions of usage, ebonite fittings to replace metal pipes, pumps, cocks, and valves, and boots, gloves, and overalls to protect the workers from contact with corrosive liquids, while reference has already been made to the development of ebonite-coated metal sheet as a structural material. The use of ebonite for battery boxes and fittings is common practice, while during recent years this material has found widespread application in the machinery used in the production of rayon or artificial silk. The rubber lining of wooden vats and tanks, followed by vulcanisation *in situ*, is now an established practice, while ebonite-lined tank wagons for the transport of liquids in bulk are not uncommon.

The provision and maintenance of flooring materials under severe conditions of factory use is another problem which frequently has to be faced by the industrialist. It seems probable that recent developments in connection with the application of rubber latex may place a new material for this purpose at the disposal of the structural engineer. When concentrated latex is mixed in appropriate proportions with an aluminous cement, the plastic mass slowly sets and yields a resistant tough material which would seem to present distinct technical potentialities. A passing mention must also be given to the use of certain rubber derivatives as varnishes where resistance to chemical influences is of importance.

Products prepared by the action of chlorine on rubber dissolved in an inert solvent and marketed under the designations of "Duroprene" and "Tornesite" were first suggested for the purpose some eighty years ago, and their recent revival provides an example of the interval which may elapse between the inception of an idea and its translation into actual practice. From this reference to derivatives of rubber it will be inferred that the material has its limitations in regard to resistance to chemical attack. Such, indeed, is the case, and rubber is readily attacked by ozone and nitric acid in addition to chlorine and bromine, and is slowly carbonised by concentrated sulphuric acid. Accepting these limitations, however, there can be little doubt that in regard to its resistance to weak acids and alkaline liquors, rubber is probably unequalled by any other material at the disposal of the engineer and the chemist.

In these times of increasingly exacting requirements with regard to the standards of purity and colour, the avoidance of contamination of chemicals, foods, and beverages in the course of preparation is a matter of first importance, and it may be recalled that in the early days of the industry, nearly a century ago, the substitution of rubber for lead tubing in the manufacture and distribution of beer and cider led to a notable fall in the number of cases of plumbism.

Consideration of the chemical behaviour of rubber naturally leads to the question of its resistance to atmospheric influences, the causes of premature deterioration, and the conditions to be observed in use and storage to secure maximum life and performance. It has already been explained that hard rubber or ebonite is a stable chemical product, which undergoes little change with long passage of time beyond a slight surface discoloration, accompanied by the formation of an acidic film which slowly reduces the electrical insulation value. With soft vulcanised rubber, the case may be different. Provided the conditions of vulcanisation have been kept within the limits of safety and the material subsequently receives fair treatment its expectation of life is a long one. For example, a rubber joint recently removed from a gas main at Newcastle was found still to possess its original elastic properties after the lapse of over sixty years.

Until the advent of the works laboratory and the development of methods of testing and production control the establishment and maintenance of correct conditions of vulcanisation for each individual mixing was a matter of judgment, experience, and care. It therefore is not surprising that in the past the rubber industry has been characterised by a spirit of caution, and that innovations took time to establish themselves in favour with the user.

Nowadays there is generally no difficulty in determining the appropriate conditions of vulcanisation for a new mixing, while accelerated ageing tests are available, which enable the durability of the finished article to be predicted with a reasonable degree of certainty. Such tests as yet may not have reached a high standard of exactitude, and do not necessarily place materials in exact order of merit, but they at least serve to detect instability due to incorrect vulcanisation or the use of unsatisfactory compounding ingredients. Technical performance now has become largely a question of selecting the appropriate material for the purpose in view, and appreciation on the part of the user of what in the particular circumstances will constitute unfair usage.

Generally speaking, the enemies of rubber are exposure to sunlight or high temperatures and the action of oils, fats, and substances which may act as oxidation catalysts. Chief amongst the last is copper, and so far as possible direct contact with this metal or its compounds should be avoided by those who desire maximum service from their rubber goods. Turpentine is another compound falling into the same category, and the predilection of some printers for this liquid for the purpose of cleaning rubber blankets is a habit which calls for discouragement. That many rubber articles will withstand sunlight and relatively high temperatures satisfactorily is common knowledge—one might cite, for instance, the pneumatic tire, the rubber road block, and the conveyor belt handling hot cake at the gasworks. But in general the user of rubber would be well advised to remember that these are adverse conditions, and that to maintain goods unimpaired in storage over prolonged periods, subdued light and a cool moist atmosphere are desirable. It should also be noted that contact with mineral or vegetable oil is not conducive to long life and that contamination with lubricating oil, for example, may seriously affect the performance of transmission belting, while the successful application of rubber in milking machines is largely attributable to the scrupulous cleanliness involved in dairy practice.

The production of rubber goods to meet conditions in which these adverse influences cannot be excluded is, however, one which frequently confronts the manufacturer. In so doing, he is faced by the fact that the absorption of mineral and vegetable oil is a natural characteristic of rubber, and that his efforts must be directed to reducing this effect by the introduction of suitable compounding ingredients.

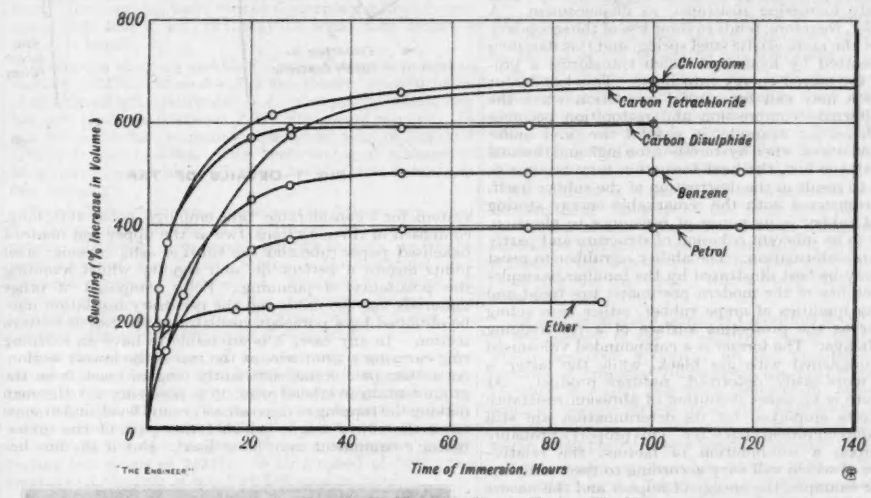


FIG. 5—*Swelling of Rubber in Various Liquids.*

Indeed, there is a close relationship between the hardness and toughness of rubber and the extent to which it is affected by oils and solvent liquids, and the materials which are adapted for use under such conditions are consequently limited to those of a relatively inextensible character. It also should be noted that oils and solvents themselves differ widely in their effects on rubber. Castor oil, for example, owing to its exceptional chemical constitution, may be regarded as practically innocuous to rubber, while the absorption of a heavy mineral oil is a very slow process, and months are required to produce the effect resulting from a few hours' contact with petrol or benzol.

Reference may be made here to two recent developments which mark a further advance in the production of satisfactory oil-resisting materials. One of these arises from the introduction of polymerised ethylene polysulphide compounds, which, in conjunction with small amounts of rubber, may be transformed by vulcanisation into tough products, which would seem to be almost unaffected by ordinary solvents. An alternative synthetic plastic which has acetylene as its starting point has also been put forward for use with rubber for the same purpose, and would seem to combine reasonable resistance to oil with a fair measure of strength and extensibility. To what extent these new materials will establish themselves in technical practice remains to be seen, but they at least point to the directions in which progress may be expected.

The first physical attribute which the word rubber calls to mind is that of withstanding remarkable deformation without permanent alteration, and no other substance is known which can be stretched to ten times its length and yet return to its original shape practically unchanged. It is this quality in conjunction with its strength and other varied properties which accounts for the use of rubber for innumerable purposes in which a more rigid material would completely fail. Take, for instance, its application as an adhesive in the construction of articles such as belting and the casings of pneumatic tires. Here its primary function is firmly to unite and consolidate the textile materials without appreciably modifying their strength and general properties. No other material is known which will meet this particular requirement. With the recent introduction of latex the possibilities of rubber are finding increased recognition in the textile trades for the production of tough, fibrous materials as well as for

special finishes, and the industry is thus extending into new fields.

One may call to mind the part which the solid tire has played in the development of mechanical transport, the use of rubber springs and buffers in railway rolling stock, and the increasing use of rubber blocks in automobile suspensions as instances of the practical use which has been made of rubber as a shock absorber, either alone or in conjunction with steel springs. From these examples it would seem reasonable to regard these two articles as allies rather than alternatives in constructional practice, to some extent representing the fine and coarse adjustments of the suspension system.

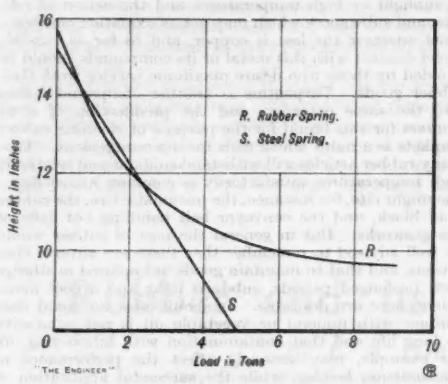


FIG. 6—*Energy Absorption by Rubber and Steel Springs.*

Rubber is perhaps more limited in its range of service than the steel spring, but it possesses the property of responding freely to initial shock and thereafter of showing progressively increasing resistance to displacement. A rubber buffer, therefore, tends to show less of the secondary liveliness of the more elastic steel spring, and this damping effect is assisted by hysteresis which transforms a proportion of the stored energy into heat. This last factor is one which may call for careful regulation when the cycle of alternate compression and restoration becomes very rapid, as, for example, in a solid tire, and under such circumstances, when hysteresis is too high and thermal conductivity too low, the heat formation may become so marked as to result in the destruction of the rubber itself.

Closely connected with the remarkable energy storing capacity of rubber is its power of resistance to abrasion, due partly to its inherent cohesion of structure and partly to its ease of deformation. The ability of rubber to resist abrasion may be best illustrated by the familiar examples of the durability of the modern pneumatic tire tread and the wearing qualities of crepe rubber, either as a soling material or as the protecting surface of a tin-dredging chute in Malaya. The former is a compounded vulcanised material toughened with gas black, while the latter is the soft, more easily deformed, natural product. At present there is no exact definition of abrasion resistance and the tests employed for its determination are still of a somewhat empirical character. This property probably depends upon a combination of factors, the relative importance of which will vary according to the conditions of use—for example, the energy of impact and the nature and shape of the abrading surface. It is a characteristic of rubber which is finding increasing recognition for a variety of technical applications, and it will be sufficient to quote three of these by way of examples, namely, the gloves and hose used for sand blast work, the linings for ball mills, and the facing of conveyor belting used for ore, grain, and coke.

There are, however, purposes for which the static rather than the dynamic properties of rubber are of primary importance. As has already been pointed out, plant and constructional problems differ widely from industry to industry, but so far as rubber is concerned they have one feature in common, namely, the need for materials to secure sound junctions between metal parts. The plastic nature of rubber and the facility with which it can be varied in consistency and moulded into every conceivable shape and form renders it a material peculiarly adopted for the many purposes for which valves, packings, and gaskets are required. The number of such products is legion, and they may vary from soft flexible materials containing little but rubber and sulphur, to hard, tough products in which rubber serves merely as a binding agent for graphite or textile or wire insertion.

In direct contrast to the solidity and rigidity of the packings we have another special form of rubber which, though relatively inextensible, is characterised by marked compressibility due to the introduction of cellular structure. The production of sponge rubber has formed a branch of the industry for many years, but until recently this product has been made with relatively coarse cells and these purposely ruptured to facilitate the penetration of water in imitation of the natural article. Latterly, the technical, as distinct from the domestic, possibilities of this product have been more generally recognised, and this has been facilitated by the introduction of methods for the production of such materials from latex and by the widespread utilisation of rubber as a flooring covering. For the purpose of eliminating vibration and shock where relatively low loads and displacements are involved sponge rubber would seem to fill a definite requirement, while the lightness of weight and relatively low thermal conductivity conferred by its cellular structure are additional features of technical interest.

It may be suggested in conclusion that the utilisation of rubber to best advantage must rest partly upon the existence of contact between manufacturer and user with a full understanding of their mutual problems and difficulties, and to an at least equal extent upon the exchange of views and dissemination of knowledge amongst the professional men who are primarily responsible for the improvement of technical practice.

Tapping Live Distribution Lines.

FOR reasons of economy, it is not always permissible to provide ring distribution lines in rural areas, and when making a connection at a point near one end of the line, it is often necessary to cut off all consumers over a wide area. Even when a ring system is in use, a long section may have to be made dead while a new consumer is being connected to the line. But this can be avoided by the use of the "Easifix" line tap equipment, introduced by the P. & B. Engineering Company, Ltd., of Tamworth-lane Works, Mitcham, Surrey. It may be used on lines working at 11,000 and 22,000 volts or more, and is claimed to be perfectly safe. The operation of tapping a line is carried out by means of a long insulated pole, either from the ground or from a ladder or platform.

A large supply undertaking that has been using the

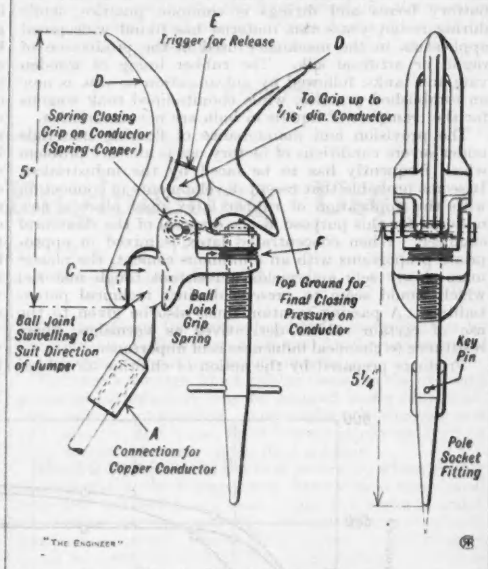


FIG. 1—DETAILS OF TAP

system for a considerable time employs poles, 16ft. long, composed of three sections, two at the upper end made of bakelised paper tube and the third of ash. Special steel joints ensure a perfect fit, and rigidity whilst avoiding the possibility of jamming. Poles composed of other materials may be used, and the necessary insulation may be obtained by a porcelain insulator at the top or bottom section. In any case, it is advisable to have an earthing ring carrying a stout wire at the top of the lowest section. As a 16ft. pole is not sufficiently long to reach from the ground to an overhead wire, it is necessary for the man making the tap, ing to do so above ground level, and in some cases the tower wagon which forms part of the undertaking's equipment may be utilised. But if the line has

FIG. 2—TAP AND OPERATING SOCKET

to be tapped, say, in the middle of a ploughed field or in the vicinity of other rough or hilly ground, a light portable staging, such as that known as a "Yankee Scaffold," will suffice.

Coming to the actual tapping device, however, shown in the accompanying illustrations, the usual jumper is first connected to the transformer, fuse, isolator, or whatever has to be fed from the line. At the other end of the jumper the socket A—Fig. 1—is sweated. The jaws D D are set open against the action of a spring by the small wire trigger E, so as to present a wide opening to the line. Owing to the spring washer F the jumper ball joint connection C is at this stage semi-rigid, and by turning the socket A upwards the tap device is made to hang vertically with the operating screw on the right downwards. The device may therefore be picked up by the operating socket on the insulated pole, so that the pin and the screw engages with the bayonet catch, also to be seen in Fig. 2. A backward turn on the screw compresses the spring washer and releases the ball joint. The device is then raised to the line and a slight pressure against it trips the trigger and the lower part of the jaws grips the line. It then only remains to tighten the screw by means of the pole until a firm grip is secured. At the same time pressure is exerted on the ball joint, which therefore gives a rigid jumper connection. Standard taps are made of bronze tinned electrically. For aluminium lines an aluminium tap with a bi-metal connector is supplied to prevent corrosion between the tap and jumper.

One supply undertaking using the system on an extensive scale employs fairly light jumpers coated with insulating material, but in most cases jumpers are made of wire stiff enough to retain their shape in the heaviest gale without risk of touching anything. The tendency is, in fact, to make jumpers stiffer than they have been in the past, with the result that they do not bend freely enough at the point of attachment to enable them to be guided by the long pole, and to meet these cases a hinged joint has been introduced as part of this live line tapping equipment. The joint is fixed to the transformer, fuse, isolator, or to whatever the supply has to be taken, while the jumper is sweated to a socket on the joint, the

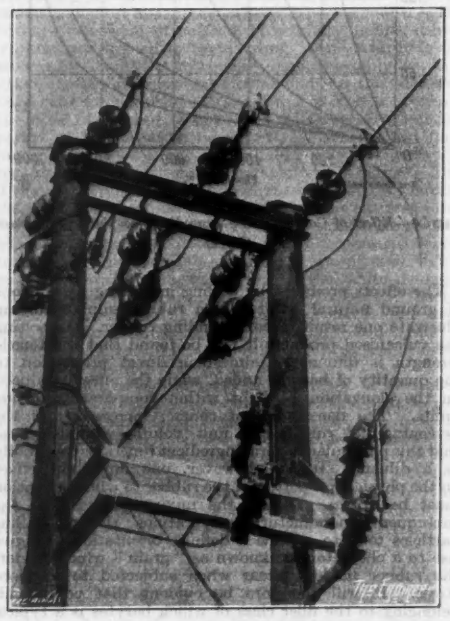


FIG. 3—11,000-VOLT-TAPPED LINE

effect being that the jumper can be swung upwards towards the wire with perfect freedom. The downward movement of the hinge is limited, so that in its final position the jumper projects horizontally with the tap at its end, and the tap is caught by the pole and pushed upwards as described. On the hinge there is a screw corresponding with that on the tap illustrated, and it is screwed up tightly by means of the pole, when the joint is made rigid. Both the screws on the hinge and on the tap jam themselves in the final position, and thus become self-locking.

The arrangement can be used as an inexpensive isolator. An ordinary insulator is, in this case, fixed to the line pole, and upon it a bracket with hinge joint is bolted. A connection is made through a hole in the bracket to the apparatus lower down the pole, whilst from the hinge a stiff rod passes upwards to the tap on the line. When it is required to open this connection, the hinge is first loosened. The tap is then unscrewed and a gentle downward pull detaches it, the rod then being lowered into a more or less horizontal position, in which it remains until the circuit is closed again. In many cases, however, the insulator on the line pole can be dispensed with and the hinge fixed directly to the transformer or fuse or other apparatus.

There are, of course, various ways of arranging the lines on the poles and to place the tap on the inner line of the three it may be necessary to bend the jumper into a suitable shape before it is presented to the line. By marking feet and inches on the upper part of the fixing pole, the dimensions to which the jumper has to be bent can easily be arrived at, and when it is elevated on the fixing pole it has the desired shape. An 11,000-volt, 3-phase, tapped line is shown in Fig. 3.

THE King's Langley accident of March 13th last led, it may be remembered, to a proposal in certain quarters that locomotives should carry powerful headlights. That idea was turned down by Colonel Mount in his report on the accident, as there already were many features outside the railway, such as heavily illuminated advertisement signs, that interfered with drivers' view of the lights of signals, and he thought that powerful headlights would have a similar ill-effect. It may also be remembered that, as recorded in THE ENGINEER of February 8th, 1935, the Southern Railway Company was able to persuade the Deptford Borough Council that some strong street lamps, interfering, as they did, with the efficiency of the lights on signals on the railway, were an offence under the Malicious Damages Act, 1861, and the Offences Against the Persons Act of the same year. Now the L.M.S. Company has obtained an *ex parte* injunction restraining the owners of a cinema at Earlestown from illuminating its exterior in such a manner as to interfere with or affect the signals on the railway.

Rail and Road.

THE Crewe Town Council has accepted the offer of the London, Midland and Scottish Railway, and the library of 20,000 books and the news-room, mentioned herein on November 20th, is to be taken over by the Council on payment of a nominal rental of £10 a year.

THE promotion, some time ago, of Mr. F. H. D. Page to the position of assistant signal engineer, Great Western Railway, was obviously made with the anticipation that he would succeed his chief, Mr. C. M. Jacobs, when he retired. It is now officially announced that Mr. Page becomes the signal engineer on February 3rd next.

THE L.N.E.R. new marshalling yard at Hull was opened on Monday, December 9th. As recorded in our Annual Article, "Railway Engineering in 1934," which we published on January 18th last, it is approached from the west by six reception lines, each holding eighty wagons. The wagons are shunted by the hump gravity system into two groups of thirty marshalling sidings in all. The wagons on reaching the foot of the hump are controlled from a control tower by four Frolich hydraulic rail brakes. The total length of the yard is 2 miles 9 chains.

ACCORDING to the Railway Returns for 1934 the companies renewed during the year 391 locomotives, heavily repaired 7793, gave light repairs to 6454, and at the end of the year 1516 were under or awaiting repair. There were 1479 passenger carriages renewed, 6477 had heavy repairs, and 50,900 had light repairs. At the end of the year 2383 carriages were undergoing or awaiting repair. In the wagon stock, 14,985 were renewed, 64,711 had heavy repairs, and 1,269,298 had light repairs; there were 24,838 undergoing or awaiting repair at the end of the year.

IN a recent paper before the Institution of Locomotive Engineers, Mr. Duncan Bailey said that by eliminating 100,000 old wagons and replacing them with modern all-steel trucks of 12 to 14 tons capacity, some 30,000 vehicles could be cleared off the railway lines. This, in addition to making a great saving in the non-paying tare weight of the vehicles, would create an annual saving in the cost of repairs and elimination of frequent stoppages of vehicles for such repairs. Such a change-over would, he contended, reduce our imports of foreign timber, and when the change-over to steel was complete, it would necessitate the production of, roughly, 180,000 tons of additional steel per annum for a considerable time.

IN a written reply to Lieut.-Colonel Moore, the Minister of Transport states that he has never said that he proposed to eliminate the horse in London. He had, however, recently made inquiries of the largest users of horse-drawn vehicles in Central London as to the rate of progress which might be expected or would be practicable in the substitution of mechanical for horse-drawn traffic, and he would give the closest consideration to any representations he received from those affected. He took the view that the presence during the day-time of slow-moving horse-drawn traffic on some of the more important streets in London slowed down other and faster-moving traffic, and added to congestion.

THE *Railway Gazette* for December 6th records a remarkable feat in British locomotive efficiency. The "Earl Marischal" was working the 10.20 a.m. Aberdeen to Edinburgh when it developed some minor trouble on the approach to Montrose, at which station it was decided to detach the engine. The load was 479 tons, and the only other engine available was a small freight tender engine, whose maximum rostered loading was 230 tons. It was, however, attached in front, and a branch line tank engine was put in the rear to bank it up the 1¼ miles of 1 in 88, followed by 1¼ miles at 1 in 111. From the summit "No. 9776," the freight engine, took the train unaided into Abroath, whence it was assisted by a small 4–4–0 engine and arrived in Dundee only twenty-eight minutes late. By some smart station work at that place and good running to Edinburgh, Waverley Station was reached only five minutes late, and the departure for London was on time.

MAKING one further, and last, quotation from the Presidential Address of Sir Cyril Hurcomb at the Institute of Transport on October 14th, we would quote him as saying that the Road Traffic Act has not resulted in strangulation or stagnation in the road traffic business. At December 31st, 1934, there were 2472 operators with only one vehicle, 1095 with two, 729 with three, and 386 with only four vehicles, and these 4682 operators, each owning not more than four vehicles, in the aggregate owned 21 per cent. of the total number of public service vehicles, excluding the vehicles of the L.P.T.B. On the other hand, there are many districts in which the small operator fulfils a local function at least as well as, and perhaps better than, a large concern. In some of the more agricultural areas the proportion of concerns owning not more than four vehicles is particularly high—they number 90 per cent. of the total and own over 40 per cent. of the vehicles owned. The conclusions may fairly be drawn that there has been no drastic interference with the small man where he is in a position to conduct his business satisfactorily or fulfil a useful economical function.

IN an address given by the Minister of Transport to the National Government Transport Committee, under the chairmanship of Sir Henry Jackson, the Minister said that last year, by arrangements made with the Commissioner of Police, particulars of all street accidents resulting in death or injury on four selected thoroughfares that had a bad record in that respect were plotted. The conditions were investigated in the light of these maps and many changes made, including the installation of light signals, the alteration of kerb lines, changes in the stopping places for buses and tramcars, the resiting of pedestrian crossing places, and the provision of refuges and pedestrian barriers. Comparison between the number of accidents in the six months subsequent to these alterations with those of the corresponding period twelve months earlier showed a decrease of 14·6 per cent. in the total; fatalities had decreased by 53·5 per cent.; serious injuries by 32·4 per cent., and slight injuries by 10·6 per cent. The decrease in the casualties to pedestrians was even more striking, the fatalities having fallen by 75 per cent, and the serious injuries by 46·3 per cent.

Miscellanea.

ADDITIONAL plant, costing some £1,200,000, is to be constructed for the International Nickel Company of Canada.

DURING the Bicycle and Motor Cycle Show at Olympia this year contracts were placed for some half a million bicycles and 30,000 motor cycles.

IT is expected that the Soviet plan for producing 92,000 motor vehicles in the Union during 1935 will be exceeded by about 3000 vehicles. The schedule for 1936 provides for the production of 140,000 vehicles.

AN organisation to be known as Air Hygiene Foundation of America has been formed by a large group representing various industries, with a view to conducting investigations and stimulating research in air hygiene.

CONTRACTS for the supply of a further 270 trollybuses have been placed by the London Passenger Transport Board. These buses will be used in connection with the scheme for the conversion of tramways to trollybus operation.

THE Secretary of Mines recently said that in 1934 the output of coal per person employed in and about coal mines in Great Britain was 280 tons. The corresponding figure for the first ten months of 1935 was 237 tons, which was equivalent to an annual figure of 284 tons.

SPEAKING at the annual dinner of the British Gas Federation, Lord Macmillan said that there were 120,000 persons employed directly in the gas industry and the annual wages amounted to over £15,000,000. He went on to say that the industry paid approximately £4,000,000 in rates and taxes and that the invested savings under the co-partner employees scheme was some £4,500,000.

AN electric miners' lamp has been invented by Professor Wm. Thornton, of the Armstrong College, Newcastle-on-Tyne, which measures the amount of fire-damp present in the atmosphere and gives an indication when the percentage of gas has created an explosive mixture. The lamp is undergoing tests by the Government Department concerned, and it will probably be some time before a report is issued.

A NOTE in the *Iron and Coal Trades Review* says that in January, 1925, furnace No. 7 of the Hörder blast-furnaces of the Vereinigte Stahlwerke A.-G. was put into blast and has now produced just over 2,000,000 tons of pig iron. In this period it has consumed 5,000,000 tons of ore and 1,850,000 tons of coke. This performance is claimed to be a world record for production from a blast-furnace in one campaign.

THE following sectional presidents have been appointed for the annual meeting of the British Association next year at Blackpool from September 9th to 16th, under the presidency of Sir Josiah Stamp:—Mathematical and Physical Sciences, Professor A. Ferguson; Chemistry, Professor J. C. Philip, F.R.S.; Economic Science and Statistics, Dr. C. R. Fay; Engineering, Professor W. Cramp; Agriculture, Professor J. Hendrick.

FOR the construction of the westerly portion of the Grand Coulee Dam in the United States it was necessary to convey some 4,500,000 cubic yards of aggregate across the Columbia River. To convey the material speedily and economically it was decided to construct a conveyor belt across the river and run it on a suspension bridge having two spans of 1437ft. With a speed of 400ft. the capacity of the belt is rated at 700 tons an hour.

A NOTE in the *Machinist* says that an excellent polishing material can be made by suspending emery or other abrasive powder in molten paraffin wax. The wax being melted and the abrasive powder added, the source of heat should be removed and the mixture stirred until it commences to thicken. A volume of abrasive powder equal to half the volume of paraffin wax can be absorbed. This paste will set hard, and is less liable to pick up dirt and grit than a more liquid paste. When used, the paraffin wax will act as an effective lubricant for the abrasive.

IN a paper on steam raising, before the Glasgow Technical College, Mr. H. L. Pirie gave some comparative figures of the cost of coal *versus* oil fuel firing for steam raising and central heating. The cost of evaporating 1000 lb. of water at a hospital was 32d. with oil and 12·55d. with coal, hand fired. At a laundry 36d. with oil and 14d. with coal, stoker fired, and at a dairy 28·5d. with oil and 18·5d. with smokeless coal, hand fired. These figures, he explained, referred to plants in the London area, but he had records of plants in Lanarkshire and Fifeshire where the cost of steam raising with coal was 5·8d. and 5·3d. per 1000 lb. respectively.

IN a recent paper before the Institution of Civil Engineers, Mr. S. B. Donkin said that with the present maximum efficiencies of power plant the overall thermal efficiency of electric generation using coal as a source of energy could not exceed 30 per cent. He suggested that by providing means for using the latent heat in steam for industrial, domestic, and horticultural heating the thermal efficiency of a combined station which generated electricity and utilised the surplus heat could be raised to 60 or even 70 per cent. where suitable arrangements could be made for the balance between the electricity demand and the heat demand. Forty towns in the United States had such combined stations, and in England a large number of individual industrial plants had already been installed.

AN unusual method of construction was adopted for a wind tunnel at the Georgia School of Technology, in the United States. The tunnel was made up of a framework of ring frames and longitudinals, to which was fastened a 3in. by 4in., 12-gauge galvanised wire mesh and a fine eight-wire screening, the screening being coated with a water-soluble glue. The glue reduced the openings in the screen about 50 per cent., and against this the inside lining coat was applied by the gunite method with small loss of mortar. After the inside was coated the glue was washed off and the outside lining coat was applied. The reinforcing steel, screening and gunite lent themselves very well to the warped surfaces at the corners, where there is a transition from circular to elliptical section. A heavy duty floor paint was used on the inside, and a satisfactory dustless finish was obtained.

Air and Water.

AN initial survey flight for a British-Scandinavian air service has been made.

THE radio beacon installed on the Nab Tower, which marks the eastern approach to Southampton, has begun to operate.

IT has been announced by the Orient Line that the new 23,000-ton vessel now being built for delivery in 1937 is to be named "Orcades."

IT has been announced in the House of Commons by the Parliamentary Secretary to the Admiralty that it is proposed to order a flotilla of seven destroyers in addition to the 1935 programme.

WHAT is said to be the greatest load of air mail ever carried by a heavier-than-air machine is being taken by an Imperial Airways flying boat from Brindisi to India and the East. It is carrying some 2½ tons of Christmas mail.

AN order has been placed by the Deutsche Lufthansa for a third floating aerodrome. The new ship, which will have a speed of 15 knots and be fitted with catapulting apparatus, will be in commission about the middle of next year.

THE first of three specially built coal-carrying vessels for the transport of coal to the new Fulham power station has been launched. Named the "Fulham," the new vessel is 245ft. long and designed for a speed of 10½ knots, with a carrying capacity of 2390 tons deadweight.

SEVEN Airspeed "Envoys" are to be delivered to the South African Government early next year. Four of these will be civil machines, and the others will carry military equipment, says *Flight*. The engines will be Cheetah IX's, with a normal output of 310 h.p., giving the machines a maximum speed of 211 m.p.h.

UP to the present, forty-five vessels have been nominated for demolition under the British Shipping (Assistance) Act. Eleven vessels of about 38,000 gross tons have been sold to British shipbreakers, fifteen of 75,000 tons gross to foreign shipbreakers, and arrangements are being made to dispose of the remaining nineteen ships.

THE United States Lines has invited tenders for the construction of a cabin liner similar to the "Washington," this being a departure from the company's original plans, and having been made necessary by the failure of the private shipyards to submit tenders based on the plans and specifications which were prepared earlier.

AN exhibition of aerodrome equipment is to be held in London next January at the same time as the annual conference of the Aerodrome Owners' Association. The exhibition will not be open to the public, as it is intended primarily for aerodrome authorities and the delegates attending the conference, which takes place on January 30th and 31st.

AN article in the *Journal of Commerce* gives particulars of the history of the "Calcutta" flying boat G-EBVG, which has been operating on the mail and passenger services of Imperial Airways in the Mediterranean. In 7½ years the boat has never been under cover and has flown on regular service more than 2240 hours, equivalent to a distance of 200,000 miles. She is now at the Short works being prepared as a training machine for pilots.

THE inquiry into the loss of the 5880-ton vessel "La Crescenta" in the Pacific Ocean last December has been concluded. The loss of the vessel was found to be due to overloading. In the course of his judgment, Lord Merrivale, the Wreck Commissioner, said that the most probable cause appeared to be seas striking the gangway and flooding the boiler-room and engine-rooms, and putting the dynamo out of action, so that the working of the machinery would cease. With a ship deeper in the water than she should be, the effects upon her of such causes would obviously be greater than in the case of a vessel loaded to a proper depth. Two contributory causes of the loss in the judgment of the Court were the limited degree of the strength and stability of the fore and aft gangways, and the overloading of the ship. The owners of the vessel were directed to pay costs totalling £3400.

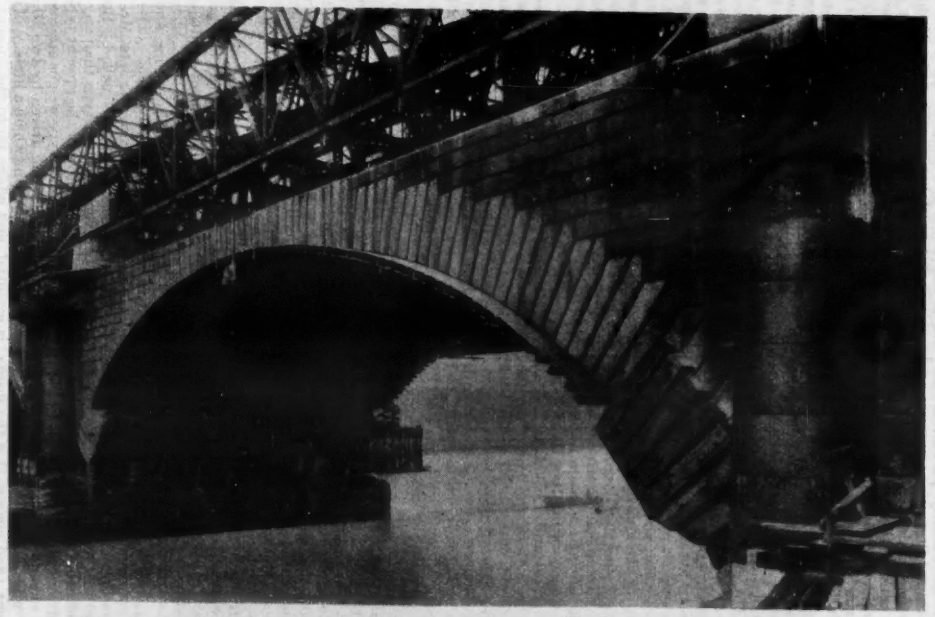
IN his review of the operation of the Tees Conservancy Commission during the year ended October 31st last, the Chairman said that during the year a new source of revenue had developed from the importation of creosote oil and the export of petrol from the Billingham-on-Tees works of Imperial Chemical Industries, Ltd. Between April, when the export of petrol began, and October 31st, 40,519 tons of petrol had been shipped from the river. The total expenditure incurred during the year on management, maintenance, repairs, dredging, &c., amounted to £80,666. Considerable progress had been made in the reclamation of the Seal Sands area. A commencement had been made with the extension of the training wall on the west side of Seaton Channel, which would not only improve its quality from a navigational point of view, but also help to retard the flow of sand from the Seal Sands into the Seaton-on-Tees Channel.

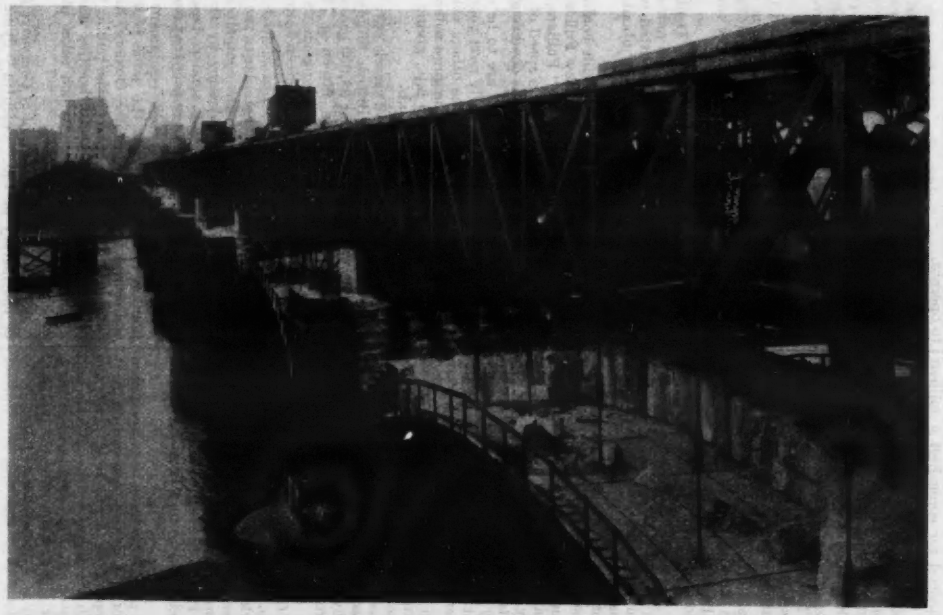
THE Royal National Lifeboat Institution has completed the first two motor lifeboats of a new type. One of these boats has been built out of a gift, in celebration of the King's Silver Jubilee, from Mrs. Elizabeth W. Montford, of Market Drayton, Shropshire, and is to be called "Royal Silver Jubilee, 1910–1935." The other has been built out of a legacy from the late Mr. John Hogg, of Boscombe, Hants, and is to be called "Rosabella." Both boats are of a much lighter type than any now in the lifeboat fleet. The lightest of the present type of boat weighs 6½ tons, whilst the new type weighs approximately 3½ tons, and is 32ft. long, being driven by two 10 h.p engines. It is intended for stations where a lifeboat of shallow draught is essential, and where up to the present it has not been possible to have motor boats. The "Rosabella" is fitted with propellers like other motor lifeboats, but the "Royal Silver Jubilee" has a Hotchkiss internal cone propeller. From the experience obtained from the latter boat it will be decided later which form of propulsion to adopt for other lifeboats of this light type. The "Royal Silver Jubilee" is to be stationed at Wells, Norfolk, and the "Rosabella" at Ilfracombe, Devon.

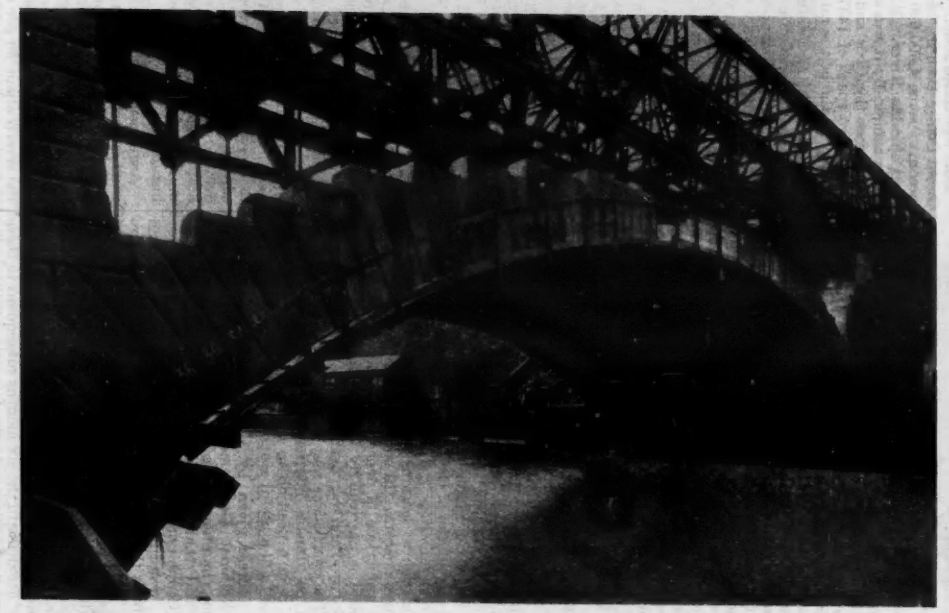
THE DEMOLITION OF WATERLOO BRIDGE

MESSRS. RENDEL, PALMER AND TRITTON, ENGINEERS: SIR WILLIAM ARROL AND CO., LTD., CONTRACTORS

(*For description see page 652.*)







ABOVE:—THE SUSPENDED CENTERING—APRIL, 1935
BELOW:—DEMOLITION OF ARCH No. 2—JULY, 1935

ABOVE:—ARCHES PARTLY REDUCED—JULY, 1935
BELOW:—JACK EMPLACEMENTS—MAY, 1935

The Engineer

DECEMBER 20, 1935.

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ONE-PAGE SUPPLEMENT—PENCIL PORTRAIT NO. IV—THE RT. HON. LORD WEIR, P.C., LL.D.

NOTICES TO READERS.

*** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

*** Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Pencil Portrait No. 4.

With this issue we present the fourth of our Pencil Portraits. It is of the Right Hon. Lord Weir of Eastwood, P.C., G.C.B., LL.D. (Glasgow), Managing Director of G. and J. Weir, Ltd., Glasgow. Director-General of Aircraft Production, Ministry of Munitions, 1918; Secretary of State for Air and President of Air Council, April-December, 1918; Chairman of Advisory Committee on Civil Aviation, 1919; Adviser to the Air Ministry on Major Problems concerning Supply and Industry, 1935.

TORSIONAL OSCILLATION.

OF the practical consequences of torsional oscillation in the torque-transmitting members of engines and other machinery there have been numerous demonstrations. One of the most striking instances on record is that provided by the German airship "Graf Zeppelin" on what was intended to be her second voyage across the Atlantic in May, 1929. Following her first successful voyage, her five Maybach engines had been fitted with superchargers and brief flights with the engines so modified had been carried out. There can be no doubt that the addition of the superchargers converted the dynamical conditions of the engines from safe to dangerous and that the added masses altered the natural period of torsional oscillation of the crankshafts to a value closely in tune with the running speed of the engines. Resonance being present, failure by fatigue became a question only of time. Within twelve hours of leaving Friedrichshafen, while the airship was over Spain, the crankshafts of two of her engines broke in succession. It was decided to return to Germany but over the Rhône Valley the crankshafts of two more of her engines fractured within five minutes of each other. After she had, with great skill, been landed near Toulon it was found that the crankshaft of the fifth engine was just on the point of fracturing. There have been corresponding occurrences elsewhere, notably in some motor ships, of which no doubt our readers have heard. Even the recognition of possible danger and the fitting of vibration dampers as a precautionary measure, has, in certain instances, failed to avert fracture by fatigue induced by torsional oscillation. Within the past few years the subject has been extensively studied both mathematically and experimentally but it still remains a source of anxiety to designers. It is scarcely possible that any engineer to-day would, as in the past, blindly incur the conditions requisite for disastrous torsional oscillation. But between the recognition of the danger and the taking of adequate measures to avoid it there is still a considerable gap across which existing scientific knowledge of the subject is not fully sufficient to carry us.

Any resilient system subjected to an external cyclically varying load must oscillate in some degree. In an internal combustion engine torsional oscillation of the crankshaft must always be present under the rhythmically varying torque applied to it by the piston forces. Torsional oscillation, if the torque is not absolutely constant, as it never is, is not some accidental defect which is capable of being suppressed but is in all cases a necessary accompaniment of the transmission of power. In many cases the amplitude of the oscillation is very small and as a consequence the stress in the part concerned fluctuates only through a small range about the mean value corresponding to the power being transmitted. In such cases the maximum value of the stress is below the fatigue limit of the metal and safety ensues. In some cases the amplitude of the oscillation and the range of stress variation may be satisfactorily small at all speeds except one, or one of a series of particular speeds. The shaft is capable of oscillating torsionally, like a torsional pendulum, in a certain natural period. It may, depending upon its construction, be capable, like certain other bodies such as a circular disc held round its periphery, of oscillating in several different natural periods. If the frequency of the cyclically varying load applied to it is in tune with one or other of its natural frequencies the amplitude of the torsional oscillation will show a marked increase over what it is when the frequency of the varying load is something above or something below the "in-tune" value. The factors which determine the extent of the amplitude—and therefore of the stress range induced by the oscillation—are, when resonance occurs, the magnitude of the load, the stiffness of the shaft and the magnitude of the damping influences acting to restrain the oscillation. The effect of the damping influences is critical. If the damping influences are powerful the amplitude of the oscillation at resonance will be relatively small and the actual point of resonance will not be sharply defined. If the damping is slight the amplitude will be relatively great and the speed at which resonance occurs will be sharply defined. So much elementary theory teaches us. The need of the practical designer is clearly some means of calculating the amplitude at resonance in order that he may determine therefrom the corresponding stress range with the object of ensuring that such range is within the safe limit with respect to fatigue. To calculate the amplitude a knowledge of the amount of damping is essential. The position at present is that not only do we not know how much damping to count upon in any given case; we do not even know with certainty what characteristics of the engine or system give rise to the damping, or, to be more precise, how much various possible sources contribute to its total. The damping influences, whatever they are, have one and only one function to perform, namely to rob the oscillation of energy and thereby limit its amount. On the Continent a commonly held view is that the main element contributing to the damping is the variation which change of speed produces in the resistance of the driven unit—say the generator or propeller or pump. In the United States Professor F. M. Lewis some ten years ago popularised the belief that the chief source of damping lay in the hysteresis of the metal composing the part in oscillation. In this country Dr. J. F. Shannon in his paper "Damping Influences in Torsional Oscillation" presented before the Institution of Mechanical Engineers on the evening of December 13th and in certain earlier writings has sought to establish the claim of the lubricant in the bearing and journals of a shaft to be the main source contributing the damping force.

We have now briefly indicated the technical history of this important subject from the early days of mishap to the enlightened—but still not fully enlightened—present. It is evident that the rationalisation of design with respect to torsional oscillation turns first upon the settlement of the factors responsible for the damping of the oscillations at resonance and secondly upon the establishment of a sound means of assessing the magnitude of the damping effect which they contribute. It seems now almost certain that the American view concerning the origin of the damping can, for the most part, be disregarded. The results of Dr. S. F. Dorey's investigation into the elastic hysteresis of crankshaft steels have been applied to show that the loss of energy through hysteresis in the steel is in general too small to account for more than a fraction of the damping required to obviate high amplitudes at resonance. It should be noted however that speaking in the discussion on Dr. Shannon's paper, Dr. Dorey conveyed the impression that he is not fully in agreement with this deduction from his results. Other considerations, nevertheless, support the view that hysteresis plays only a minor part, if any, in the damping of the oscillations at resonance. What we have called the Continental view cannot be similarly disregarded. It seems certain that in some cases the rise of resistance with speed of the machinery driven must exert a powerful damping influence although equally other instances might be named in which it seems doubtful whether it could be sufficient by itself to provide the amount of resistance requisite to suppress excessive oscillation at resonance. Dr. Shannon's belief in the efficacy of the lubricant in the shaft bearings as a damping agency is well supported by his experimental investigations and does no violence to our preconceived ideas when it is studied in full detail. Its adoption by designers would not necessarily require them to discard the Continental or the hysteresis theory. There is no reason why the damping influence should reside only in one factor. There is every reason to expect that in many cases it owes its origin to two or all three of the suggested causes acting simultaneously.

A Mad World.

IT is not often that we report in our pages the speeches of the chairmen of foreign companies to their shareholders. But the address which Dr. Schindler delivered at the annual meeting of the Oerlikon Company in Switzerland a few weeks ago deals so much more with the industrial economics of the whole world than with the immediate affairs of the company that we give a translation of it practically in its entirety. The author is well known, even in this country, as an exponent of strong, but common sense views upon world economics, and as a confirmed opponent of more than moderate import duties. In this address he surveys briefly, simply, but effectively, the leading economic movements which have taken place since the war—and condemns them all. He speaks, of course, as a member of a nation which has suffered exceptionally by the depression in international trade and by the repressive policy which has been adopted and developed by countries obsessed with an extravagant desire for nationalism. But it is unnecessary to make much allowance for the effect which the plight of Switzerland must have had on his views. No doubt he would have been silent had Switzerland been prosperous, yet, nevertheless, there is scarcely an impartial economist who will deny the fundamental truth of any one of his statements and only a few, perhaps, who will not share his regret that the conditions of international trade and of less reliance on the State, which existed in pre-war days, are no longer to be found.

If we could imagine a perfectly intelligent being with unlimited power to effect his will taking into his hand the control of the economics of all nations, could we not say with considerable safety that he would not do a single one of all the things that are now done? His object would be to make the whole world act together in accord for the benefit and welfare of all, and he would condemn a system of nationalism which, by its egoism, must, as Dr. Schindler foretells, in the end destroy the contentment of all. Would he not stand amazed at the sight of any nation of the world restricting, almost to the point of prohibition, the purchase of goods made by other nations and, in consequence, the ability of those nations to purchase its own products? Knowing that money is only profitable whilst it is in circulation, he would be moved to laughter or anger by restrictions which prevent the transit of money between nations. He would listen with attention, but impatience, to the plea of all nations that the

economic condition resulting from the depression had obliged the imposition of exceptional measures, but he would surely add that any nation which planned for its own good even if it damaged its neighbour was pursuing a false path. All this is, in fact, the substance of Dr. Schindler's argument, and, as we have said, we believe that no unbiassed economist will quarrel with it. Indeed, there will be general agreement with the principle whilst there is a general agreement to disregard it. "I am convinced," says Dr. Schindler, "that we have reached the limit of what can, in the long run, be borne, and have even exceeded it. . . . We must not allow ourselves to be led deeper into the morass through illusions of State help. We must rather strive to recover free intercourse in trade and to bring to an end the restrictive economic system; we must aim at stable currencies, at economy in industry, and in the sphere of public administration, and finally, at a policy of long-term trade agreements with moderate tariffs, in spite of the outcry of opposing interests. There is in the long run only one effective means of promoting exports—that is by facilitating imports. It is only when industrial countries are prepared to buy from the agricultural countries the surplus production of the latter and the agricultural countries to take, in return, the products of the industrial countries, that sound, economic conditions can be restored throughout the world."

There is a resemblance not very remote between the industrial conditions of Switzerland and Great Britain; both have owed in the past their prosperity to their export trade, and both suffer by anything that hampers the free movement of that trade. In one sense, we suffer and are suffering more than Switzerland because our great mercantile marine was, and still is, in great part rendered idle by the determination of every country that counts on the globe to restrict imports, and, as far as is possible, to satisfy by its own efforts its own requirements. Admittedly, many of them, this country included, have been forced into that policy by the acuteness of unemployment, but it is at least questionable whether the very means which have been adopted almost universally to increase employment have not checked it by the restriction of international trading. Happily, there is no economist in the world who does not recognise that unscaleable tariff barriers are a disadvantage to every one, and there are, therefore, always some grounds for hoping that when another World Economic Conference is held means of lowering them, and thereby of facilitating that free flow of trade and money upon which the true prosperity of all nations depends, may be found. Dr. Schindler's clear-cut description of the reactions of present world economic movements may help to open the road to that reformation.

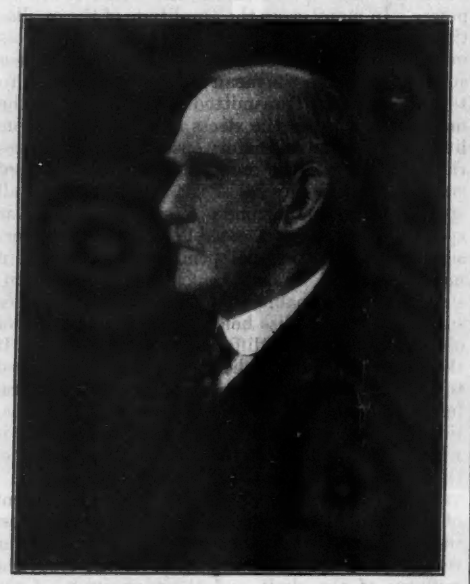
Obituary.

SIR RICHARD TETLEY GLAZEBROOK.

THE position which Sir Richard Glazebrook, whose sudden death at the age of eighty-one on December 15th will be widely lamented, occupied in the field of engineering came to him accidentally. He was by training and inclination a physicist, but with the establishment of the National Physical Laboratory largely through his efforts and inspiration, and the establishment there of engineering and metallurgical departments, he was constrained to take an active interest in many engineering questions, notably in those associated with exact measurements, standardisation of dimensions, and interchangeability. Of all the work he did in his time, and he was indefatigable, that by which he will be remembered is the organisation of the great laboratories at Teddington. From the very first, it may be said, he had visions of the position to which the N.P.L. would ascend and the dimensions it would attain. He foresaw at an early stage that it would rise from an institution of modest dimensions for the standardisation of weights, measures, and physical constants to the position of an independent test house of international reputation. Indeed, our older readers will recall the anxiety which many independent testers suffered when a price schedule for the making of tests of material was announced by the Laboratory. Despite opposition, Sir Richard continued in his determination, and the N.P.L. acquired a reputation which puts a hall-mark on its reports. But the testing of materials and the calibration of products like meters and thermometers very soon became only the routine and bread-and-butter part of the work. Under Sir Richard's guidance the engineering and metallurgical departments rapidly assumed positions of great importance in the realm of research. The Tank and the Wind Tunnel followed, whilst as new subjects arose—wireless, for example—new laboratories were added, until the staff at Teddington had risen from the handful with which it began to the 600 which it now numbers. All this did not occur, of course, during the twenty years that Sir Richard Glazebrook was Director. Much of it happened under Sir Joseph Petavel, his successor in 1919. But one may say that it was his spirit that inspired the work, and to the very end his touch with the Laboratory was close.

Sir Richard was born in Liverpool on September 18th, 1854, the son of a doctor. He was educated at Dulwich College and later at Liverpool College, whence he obtained a scholarship at Trinity College, Cambridge, in 1872. There he graduated Fifth Wrangler in 1876, was elected a Fellow, and for several years, till 1896, was a Lecturer and Assistant Tutor. There also he worked in the Cavendish Laboratory, first as Assistant and then as Assistant Director to the late Lord Rayleigh. In this period he organised the teaching of practical physics and published numerous scientific papers. In 1882 he was elected a Fellow of the Royal Society. His text-books, of which several are still in use, are rather typical of the man—precise, accurate, clear-cut, but rather dry and scheduled, the work of one rather concerned with the naked truth than with picturesque adornments.

In 1898 he left Cambridge to become Principal of University College, Liverpool, but in the following year it was decided to convert Bushy House into a national laboratory, and he was appointed first



SIR RICHARD TETLEY GLAZEBROOK

Director. The work of organisation fell to him, and after the laboratories—there were only two, with a staff of twenty-six—were opened in 1902, expansion was rapid. Twelve years later the staff amounted to 200. With the War, the special duties imposed upon the laboratories caused a further rapid but abnormal increase.

To mention all the other work that Glazebrook did, even whilst he was Director of the N.P.L. and subsequently, would be to cover a wide field, for he was the chairman of many committees, president of several societies, including the Institution of Electrical Engineers, and the author or editor of several important works. We must note especially that he was Chairman, from its foundation in 1909, of the Advisory Committee for Aeronautics and of the Aeronautical Research Committee which followed it, until 1933. For four years, 1920–23, he was Zaharoff Professor of Aviation and Director of the Aeronautics Department of the Imperial College.

He was knighted in 1917 and three years later was made K.C.B.

DONALD A. MATHESON.

MANY of our readers whose interests lie with civil engineering and railway work will learn with regret of the death on Tuesday, December 10th, of Donald Alexander Matheson, engineer-in-chief, and later general manager of the old Caledonian Railway Company, and for some time the deputy general manager for Scotland of the London, Midland and Scottish Railway Company.

Mr. Matheson, who retired from active railway service in 1926, had not been well for some three months, and he died at his home in Glasgow in his seventy-fifth year. He was born in Perthshire and received his early education at Perth Academy. Later he studied engineering at Watt College, Edinburgh, and Owen's College, Manchester. Following a period of practical training, both at Perth and at Edinburgh, he was appointed to Manchester as an assistant to Mr. S. B. Wortington, who was then the engineer of the Northern Division of the London and North-Western Railway. In 1896 Mr. Matheson returned to Glasgow as district engineer on the Caledonian Railway, and immediately started on important constructional works. These included the building of the Lanarkshire and Ayrshire Railway, for which he acted as contractors' engineer and agent, and the Caledonian Railway Company's Glasgow Central Underground Railway, for which he was resident engineer. In 1899 Mr. Matheson succeeded Mr. George Graham as chief engineer, and took the leading part in the extension and the reconstruction of the Central Station and the building of the new bridge across the river Clyde, which is one of the widest railway bridges in Great Britain. He was also responsible for the carrying out of many other important works throughout the Caledonian Railway system, including the scheme for Gleneagles Hotel, which was his own. When, in 1910, Mr. Guy Calthrop went to South America, Mr. Matheson became the general manager of the company, and for many years was closely associated with the board of directors serving at first under the chairmanship of Sir Charles Bine Renshaw, and later under the chairmanship of Mr. Henry Allan. In 1912 Mr. Matheson was *ex officio* nominated a member of the Communications Board attached to the War Office and the Board of Trade, and in that capacity represented the Scottish railways throughout the whole war and subsequently. At the end of 1916 he, in company with several other railway managers, visited the Somme valley railways and arranged for the despatch of English and Scottish railway materials to France. In 1922 he was appointed deputy manager for Scotland of the London, Midland and Scottish Railway Company, a position which carried with it the management of the Scottish Division, comprising the Caledonian, Glasgow and South-Western, and Highland Railways. It is of interest to record that for twenty-eight years without a break Mr. Matheson travelled on every Scottish Royal train. He travelled in America and gave papers before the Institution of Civil Engineers on various aspects of American railway practice. He was a valued member of the Institution of Civil Engineers, and a holder of the "James Watt" and "George Stephenson" medals. Mr. Matheson was also a Past-President of the Institution of Engineers and Shipbuilders in Scotland.

PERCY CARLYLE GILCHRIST.

PEACEFULLY after long illness, Percy Carlyle Gilchrist died on December 15th in his eighty-fourth year. It is hardly a matter for surprise that many, while remembering his name, should have forgotten that he was until this week still with us. It is fully fifty years since the death of Sidney Gilchrist Thomas, his cousin, with whom he collaborated in the development of the Thomas and Gilchrist process for the production of basic steel.

He was born in December 1851 at Lyme Regis, Dorset, and was the eldest son of Alexander Gilchrist, a barrister. His education was received at Felsted Grammar School and at the Royal School of Mines. Towards the end of 1875 he was engaged as a chemist at certain works at Cwm Avon in South Wales. Early in 1876 his cousin Sidney Thomas wrote to him giving details of his theory concerning the dephosphorisation of steel in the Bessemer converter. Thomas at that time was still a clerk at the Thames Police Court but for some years previously had been studying scientific subjects in his spare time and had been attracted by the problem of dephosphorisation. Bessemer himself and many others had been engaged on the same study since 1860 but without success. The Bessemer converter removed all the contaminations from iron except phosphorus. As a result the demand for hematite and other ores free from phosphorus had sent up the price to double its former level and had led to wild speculation in Spanish ore-bearing areas. The problem of breaking down the bond which unites phosphorus to iron appeared to be insoluble yet it was recognised that if it could be resolved not only would great quantities of British, French, German and Belgian ores become available for steel making but from the phosphoric slag a large quantity of valuable agricultural fertiliser would be recoverable.

Thomas desired his cousin Gilchrist to undertake experimental work on the subject for which he himself had not the time nor the opportunity. At first Gilchrist considered the whole thing a chimera but nevertheless undertook to make some experiments. In the autumn of 1876 Gilchrist left the Cwm Avon works and entered the Blaenavon Works as analytical chemist. Those works at that time were under the management of Mr. Edward Martin who subsequently played an important part in the development of the basic process. Further reflection and experiments convinced the two cousins that the failure of the Bessemer converter to remove phosphorus resided in the fact that it was lined with silicious material and that the provision of basic linings together with basic additions to the molten metal would effect the removal. Experimenting at the Blaenavon Works first with a 6 lb. converter then with one of 3 cwt. to 4 cwt. capacity and finally with one of 12 cwt. they found that the use of a lining consisting of limestone and silicate of soda secured the dephosphorisation of the charge. It was an essential feature of the process that the wastage of the lining should be avoided by making large basic additions to the charge in order to secure a highly basic slag at an early stage of the blow.

In 1878 Thomas and Gilchrist prepared a paper on

the subject for submission to the autumn meeting of the Iron and Steel Institute at Paris. The paper for lack of time was taken as read and was not discussed. The occasion however was not unfruitful for during an excursion to the Creusot works Thomas attracted the attention of Mr. E. W. Richards manager of Bolckow, Vaughan and Co. Mr. Richards visited Blaenavon, saw some experimental casts and became convinced of the practical success of the process. Under his charge, a 30-cwt. basic converter was erected at the Middlesbrough works and after some initial difficulties connected with the lining the first successful operation of the plant was carried through on April 4th 1879.

Other investigators had meanwhile been making progress with the same problem, notably George J. Snelus and Edward Riley. To avoid litigation the interests of all parties concerned were merged in 1882 in the Dephosphorising and Basic Patents Company, Ltd. Following Thomas' death in 1885, Gilchrist as managing director of that company took out certain new patents but only the original patents of Thomas were ever really used or licensed.

Of the subsequent history of the process it is unnecessary to say more than that it was duly extended to the Siemens open-hearth process, that its use was taken up actively on the Continent while in this country it gradually ceased to be employed extensively until quite recently Stewarts and Lloyds, Ltd., revived it at their new works at Corby, Lincolnshire. Mr. Gilchrist survived until that revival had taken place but it is hardly to be supposed that he died with a clear knowledge that it had occurred.

Literature.

West Highland Steamers. By C. L. D. DUCKWORTH and G. E. LANGMUIR. Richard Tilling, London. 1935. Pages 239. Price 6s. net.

ALTHOUGH the authors modestly state that a book of the type under review "involves little or no creative work," the amount of time necessary to abstract all the information embodied in it, involving delving into many an ancient document, must have been so great that it could only have been undertaken by men to whom it was a real labour of love. This is apparent as we scan its pages, and notice the affectionate manner in which they allude to many craft whose names have been household words in their day, and a chord will be struck in the hearts of all ship lovers when they peruse this history.

We cannot help feeling glad that at the time of writing the grand old "Columba," which is illustrated by a coloured frontispiece, was still in service, bearing her fifty-seven years lightly and punctual to the end.

The mention of "Columba," however, suggests the criticism that the title of this admirable book is somewhat of a misnomer, for if she be regarded as a West Highland steamer, then the Clyde railway vessels and others privately owned should be included, for "Columba" spent practically all her days on the Glasgow-Ardrishaig run. Again, there is no reference to the McCallum, Orme, and Langlands steamers. The book is actually a history of the vessels belonging to the fleet that is now known as David MacBrayne, Ltd. Incidentally, as about 12 per cent. of the pages are devoted to motor vessels, the interesting question is raised as to whether they will continue to be classed as "steamers," even as we still speak of steamers "sailing"; but it is certainly true that when the modern oil-electric "Lochfyne" approaches Dunoon, the loudspeaker on the pier announces "Steamer for Ardrishaig," and perhaps we may exonerate the authors.

This book is divided into three chapters, the first one being concerned entirely with the ownership of the fleet from 1851, the year in which the West Highland Steamers operated by Messrs. Burns passed into the hands of David Hutchison and Co., a fleet consisting of nine vessels.

Chapter II occupies 184 pages, the bulk of the book, and describes in more or less detail each steamer and motor vessel that has been owned and worked by the company. In some cases the information is rather meagre, and readers would welcome further detail. After this chapter a number of pages are left blank so that the methodical reader can keep his copy up to date.

Chapter III is devoted to general notes on the "steamers" of the fleet, giving the authors' personal impressions, and we find ourselves generally in agreement with their sentiments. We read with interest that "it can be truthfully stated that about 1929–30 the MacBrayne fleet was a living museum of marine engineering." Although it is agreed that there was a "representative collection of types," we notice that the authors do not draw attention to the fact that no turbine steamer has been employed in this fleet, an omission which is likely soon to be made good, as the company, jointly with the London, Midland and Scottish Railway, recently acquired the Williamson-Buchanan interests on the Clyde, and so some celebrated turbine steamers pass into the joint ownership. Here will be ample material for some of the blank pages.

The book concludes with tables giving particulars of all the vessels. From the point of view of the engineer it would be distinctly valuable to have considerably more statistical information incorporated in these tables, such as boiler pressures, type of boilers, method of firing and fuel, diameter of paddle wheels and propellers, and their speed of revolution. We should also welcome some indication of the relative efficiency in service of some of the types employed. There must exist some valuable records of vessels as dissimilar as "Columba" and "Lochfyne," which have, during the last few years, operated on the same route, even though at different seasons.

The authors are to be congratulated on having placed on record the story of these celebrated Scottish veterans.

Elements of Strength of Materials. By S. TIMOSHENKO and GLEASON H. MACCULLOUGH. London: MacMillan and Co., Ltd. 1935. Price 14s. net.

PROFESSOR TIMOSHENKO'S "Strength of Materials" is well known and appreciated by teachers of engineering, and the present volume, described as an outgrowth of that larger work, is really the result of a severe pruning of the original interesting text-book. The effect of this is that a large amount of the matter which made Professor Timoshenko's treatise interesting and different from the ordinary text-books on strength of materials has been cut out. As a result the subject is presented in tabloid form, the material being selected and arranged with such a number of well-chosen problems that one might be excused for supposing that the book had been specially prepared for passing students through the ordinary examinations in strength of materials in engineering schools. As a preparation for an examination in the subject, this work would be welcomed by students, but there is a danger that successful candidates might have only a very superficial knowledge of the subject. The authors evidently consider that the illustrative problems—there are 434 of them—are of serious importance. Owing to their number a more full discussion of many important points has had to be omitted, necessitating repeated references to Professor Timoshenko's larger work.

There is little to call for special remark in the arrangement of the subject. The student is introduced to Mohr's circle of stress early, and in the chapter on riveted joints structural work is discussed as well as joints in pressure vessels. Reinforced concrete beams are treated sensibly from first principles, the student being saved from being involved in a mass of formulæ. In the chapter on long struts Euler's formula is first considered, and then there is a very brief discussion of empirical formulæ. The student is likely to be puzzled when he reads that Johnson's Parabolic formula is "sometimes" used. The discussion of factors of safety and working stresses is not complete enough. The earlier the young engineer understands how working stresses should be assumed the better. The last two chapters on energy of strain and mechanical properties of materials must be regarded merely as the outline for instruction in these subjects which will need to be supplemented by lectures and laboratory work. It is evident that physical properties at high temperatures, fatigue and various strength theories cannot be adequately discussed in a dozen pages.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE HUMAN MACHINE.

SIR,—The article "The Human Machine" in your issue of December 13th invites me to answer certain questions on the thermo-dynamics of muscle. There *are* no differences, at least no significant differences, of temperature in a working muscle, and the muscle is *not* a heat engine. In all practical heat engines, chemical energy is first transformed into heat, and then part of the heat into work. It is possible, however, to turn chemical energy into work by other paths, *e.g.*, *viâ* electrical instead of thermal energy. The chemical process which occurs in the Daniell cell,

$$Zn + CuSO_4 \longrightarrow Cu + ZnSO_4,$$

can go on at constant temperature, and in so doing it produces an electric current which may drive a motor and do work. There need be no differences of temperature in the system, but chemical energy is used and work is done. The ratio of work to chemical energy is the "efficiency"; the difference between them appears as heat.

There are plenty of other ways in which chemical energy could be transformed into work at constant temperature. For example (though this would be very inefficient !), sugar could be turned into alcohol and CO_2, and the CO_2 could expand and work a piston. Which particular way the muscle has chosen is not yet clear, though undoubtedly molecular rearrangements and probably electrical forces are involved in it. The essential fact, however, is certain—that in muscle the chemical energy liberated by combustion produces work by some other means than by being first transformed into heat. If engineers can imitate this process—some day they will—and turn the energy of coal and oxygen directly into electrical energy, then they will succeed in reaching efficiencies far higher than the 20 to 30 per cent. of which they complain. May the muscle be an example to them !

The muscle is essentially a compromise, with its primary function to exert and to maintain the forces necessary for the animal's posture and ordinary existence. As the writer of your article rightly says, such a compromise is not normally found in machines of man's devising. Again, however, an analogy may help. An electro-magnet is used for holding a piece of iron. By itself the magnet may do little or no work, but the energy it consumes (in the form of electric current) must increase with the pull it has to exert, and with the time during which it exerts it. It *can* do work, if the conditions are properly arranged, and in the electric motor electro-magnets work with very high efficiency; but if electro-magnets had to be used, not only for doing mechanical work, but for many static purposes, such as holding things in position, their design would have to be a compromise, and their efficiency in their secondary function of doing mechanical work would be less. A muscle's efficiency, nevertheless, may be 25 per cent. What might it have been had it been designed for the single purpose ? and what efficiencies may engineers attain when they give up turning the energy of combustion first into heat (with all the resulting disadvantages of high temperatures) and transform it instead directly into what they want ? It is no good saying it cannot be done; the muscle does it, and is a standing challenge, Sir, to you and your colleagues. A. V. HILL.

London, W.C.1, December 16th.

SIR,—The puzzle mentioned in your Leading Article of December 13th is due to the fact that your leader writer is looking at the question from the thermo-dynamic point of view, whereas it is, in fact, a chemical problem.

If it had been, as he supposes, a question of thermo-dynamics, the correct sink temperature would be approximately −40 deg. Fah.

STANLEY COLES.

Harpenden, Herts., December 16th.

POWER FOR NOTHING.

SIR,—"Felix qui Potuit," in your issue of November 29th, is looking for a victim. So be it. I have not seen how it is that he arrives at his specific figures (279,300, 55,860, 131,100, and 230,200). The two former are in the ratio of 5 to 1, which presumably connotes that the initial volumes and their expansion curve areas are of the same ratio. My difficulties begin, however, with his second pair of figures, which are in the ratio of 13 to 23, nearly.

The cylinders, we are told, are to be in contact till the temperatures are equal. I take it that the conditions at this point are as follows:—

Mean temperature, 3000 deg.

1 lb. heated to 3000 deg. from 1000 deg. rises in pressure to 300 lb. from 100 lb.

1 lb. cooled to 3000 deg. from 5000 deg. falls in pressure to 60 lb. from 100 lb.

The respective initial volumes remain, one supposes, what they presumably were at the commencement, namely, 1 and 5.

Now to get these down to atmosphere:

1 vol. at 300 lb. must be expanded 8·4 times, and
5 vol. at 60 lb. ,, ,, 2·75 times.

The expansion areas will be in the ratio of the hyperbolic logs=2·9957 and 1·3862. Now these expansion areas are not as "Felix" makes them.

May we have some explanation before proceeding ?

London, E.C.1, December 11th. W. J. T.

EXTENDED EXPANSION I.C. ENGINES.

SIR,—The article on the merit of the extended expansion I.C. engine in your current issue is both interesting and valuable if it awakens further work in this somewhat neglected field of the improvement of efficiency in the I.C. engine.

I and others have tried many times in the past to stir up the younger and to try their hand, but so far without success.

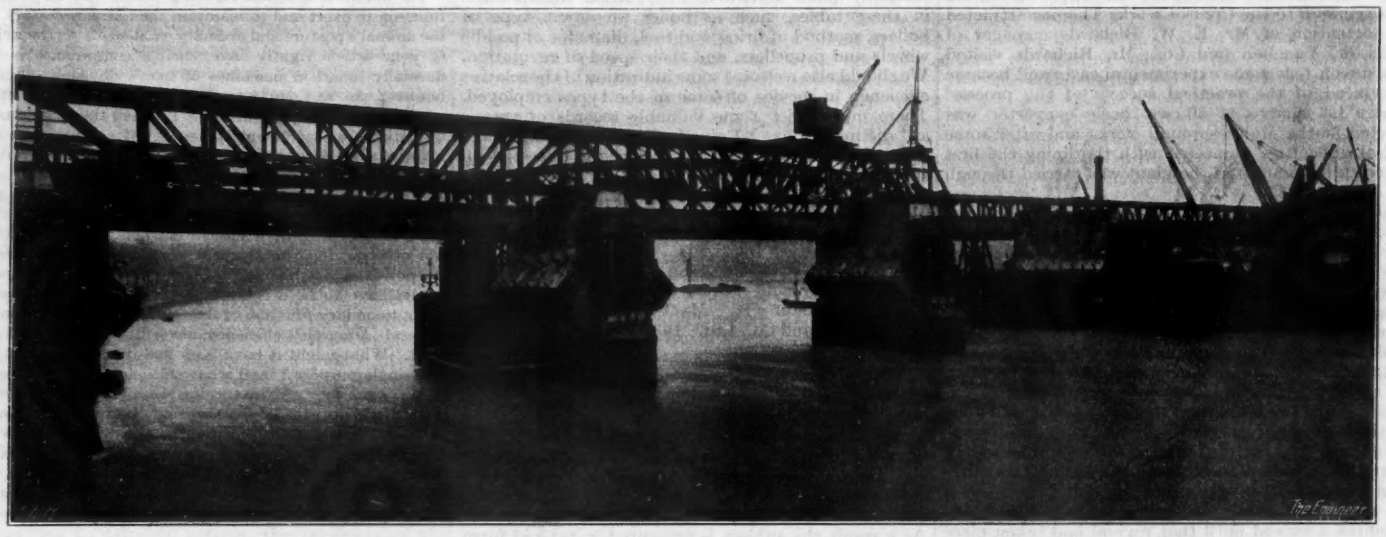
Both the mechanical longer stroke (Atkinson) and the suction cut-off are well known. The former, it is thought, is being explored at Cambridge, though the gear is not Atkinson's. Perhaps we may have some results before long.

Amongst other variations there are two which perhaps Mr. Giffen will investigate. The two-stroke, with auto-charging, as was successfully done with the Humphry pump, the exhaust pipe being of such a length that the swing-out, creating a vacuum in the cylinder, draws the new charge in; and the mechanical or suction controller type, with a variable compression. In this type, with the shorter compression strokes, the compression is put up higher than in the standard engine because temperatures are lower. ALAN CHORLTON.

London, S.W.1, December 17th.

ACCORDING to the recently issued return of the Board of Trade, last year fifty-four steam and motor merchant vessels of 78,188 gross tons, registered in the United Kingdom, were wrecked; thirty-two of these losses were caused by stranding.

STATE OF DEMOLITION OF WATERLOO BRIDGE, LONDON, ON DECEMBER 2ND



The Demolition of Waterloo Bridge.

THE demolition of Waterloo Bridge across the Thames in London was begun by the contractors, Sir William Arrol and Co., Ltd., on June 20th, 1934. Under the direction of the London County Council's appointed engineers, Messrs. Rendel, Palmer and Tritton, in association with Mr. T. Peirson Frank, the Council's Chief Engineer, the work has been carried out cautiously and safely without untoward incident, and a stage has now been reached at which all the arches have been demolished and work upon the removal of the piers has been begun.

It is now nearly a year since we last referred to the progress made. At the date of our last article in January of the present year little more than preparatory work had been done. The balustrading had disappeared and the clay filling beneath the roadway been removed; concrete supports had been built above each pier and carried the four temporary gantry girders over each arch except No. 5, which was supported by timber work from below. Preparations had been made for suspending centering beneath the arches from the gantry girders above. This suspended centering is seen in a photograph taken on April 1st and reproduced on page 648. It was carried at each arch by thirty-two hangers and consisted of thin steel plating fixed to cross members carried on steel ribs shaped to the curve of the arch. On each side it projected so as to form a convenient gangway for access to the outer stones. The centering was constructed in panels of convenient size, seven to a span, and each panel was erected on a pontoon, and, after floating under the arch, was lifted on temporary frames into position and attached to hangers carried by the gantry girders above. Each panel was jointed to adjacent panels by hinged connections. Where the bridge crossed the Victoria Embankment on the northern side, the arrangements for suspending the centering were identical, but the centering itself consisted of six steel girders with the necessary cross beams and steel plating. Whereas the remainder has been removed, this centering is still in position, and, together with various other precautionary structures, protects vehicles and pedestrians in the street from any possible untoward occurrence. The system of suspended centering was, of course, adopted in order that work on the bridge should interfere as little as possible with the river traffic which was already sufficiently hindered by the timber supports beneath the weak arches and the existence of the temporary bridge alongside.

Before the real work of demolishing the arches could be begun a good deal of preparatory work had to be done. As it was known that at a certain stage of the demolition the weight of the temporary gantry girders, together with that of part of the heavy arch masonry, together totalling about 800 tons per span, would need to be carried by the old piers unbuttressed by the arches, the nature and condition of the piers was carefully examined by means of holes bored vertically into the hearting and the use of an illuminated mirror lowered into the holes. The piers are constructed of sandstone faced with granite, and the masonry was found to be in good condition. At the sunken pier—No. 5—special precautions were necessary. Not only had the arches on each side of the pier been distorted with the result that the lower portions of the joints between the arch stones had opened, but also there was, in addition, an arching effect in the masonry above the pier. In fact, the two spans were acting to some extent like a single arch making the condition of the structure at this point somewhat unstable. The effect was eliminated and the normal arch action induced again by cutting the vertical chases, seen in an engraving on this page, in the upper portions of the masonry on each side of the pier after filling the open joints between the arch stones with lead.

It will be observed from the engraving at the head of this page that the masonry forming the springing of each arch was left in position when the arch was removed. The courses of masonry are inclined to the horizontal at these points in order to take the thrust of the arches, but on the removal of the latter they are left in an unstable condition in which slipping might occur. To counteract this effect, and for other reasons, reinforced concrete beams were constructed in the voids existing in the piers, and timber supports under the unstable masonry were linked to the beams by steel rods. At the abutments special arrangements had to be made to meet similar conditions at the springing of the arches and to carry the gantry girders. On the Surrey side the sloping courses of masonry are held up by the buttress action of a concrete mass carried on inclined piles driven into the foreshore, but on the Middlesex side, owing to the presence of the Victoria Embankment, a similar arrangement could not be adopted. Here the girders are carried on four reinforced concrete columns constructed in shafts which were drilled vertically into the masonry to a depth of about 35ft. At this level the masonry courses become horizontal and the columns are firmly bonded into them, so that, now that the arch has been removed, the sloping courses of masonry in the abutment are held up by their cantilever action.

VERTICAL CHASES AT PIER NO. 5—MARCH, 1935

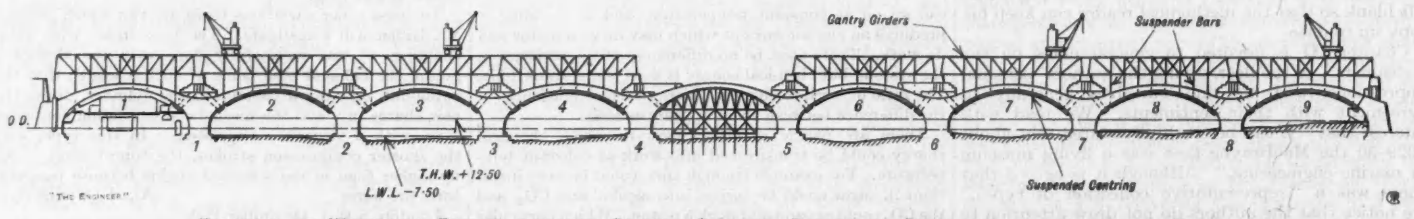


DIAGRAM OF WATERLOO BRIDGE SHOWING GANTRY GIRDERS, SUSPENDED CENTERING AND SUSPENDER BARS

Stages in the removal of the arches are shown by the engravings on page 648. In order to retain the balance of thrusts on the piers, the demolition was carried out simultaneously and uniformly at each arch, and each arch was treated in three longitudinal strips. The stones in the outer strips, each about 16ft. wide, were removed by a process termed "nibbling." Work was started at the outer keystone, and when it had been broken out and removed, only the weight of those stones which were thereby loosened was thrown on to the centering. After some of this load had been removed, the next keystone was broken out and work proceeded in this fashion until the whole of the two outer strips of masonry had been removed. By this means the total load thrown on to the gantries at any time was kept down, and the cost and weight of the temporary structure thereby reduced. Before the demolition of the central strip, about 12ft. wide, was begun, its weight was transferred to the suspended centering by the use of the hydraulic jacks shown in an illustration on page 648. All the hangers were strained by the simultaneous jacking until the whole load had been transferred gently and evenly from the piers to the suspended centering. By this action the gantry girders were deflected a maximum of about 1¼in. During the time in which the remaining arch stones were being removed, the deflection of the girders was maintained by stacking the arch stones in the middle portion of the suspended centering, as it was desirable that the deflection should not alter appreciably until the stones over the ends of the suspended centering were removed.

The whole of the masonry taken out of the bridge has been loaded into barges by the cranes running on tracks above the two inner girders, and after the arches had been demolished the suspended centering was removed in the same fashion. The next job to be undertaken was that of dismantling the outer girders by the use of the cranes running on the inner ones. At the end of last month a beginning was made in the work of cantilevering back the two inner girders towards the banks on either side, and at the time of writing no steelwork covers the spans Nos. 4, 5 and 6. The timber supports for span No. 5 are in course of removal, and the superstructure, down to the level of the reinforced concrete beams of No. 5 pier, has been demolished. In the not far distant future the work of building steel sheet pile cofferdams, within which the demolition of each pier will take place, will be begun.

Economic Changes During the Years 1905-1935.*

By Dr. D. SCHINDLER.

The Times of Security.

TRANSITION from lean years to prosperous years has always been the rule in trade. These changes in economic conditions were, however, less acute before the War than to-day. Wages and profits were modest. On the other hand, losses for the investor, and unemployment were less frequent than now. When compared with present times, pre-war days were times of security. Most currencies were secure, sales were secure, trade agreements covered long periods, and meant security for the export trade arising from such agreements. This was more than a mere amenity. An exporting concern that has dealings with the whole world cannot be built up when there is no security for export, and there is a possibility that a market gained after much effort may be closed at any day by an arbitrary tariff policy. The trade agreements covering long periods made it possible to enter into business relations with all civilised nations. The security of currencies and the knowledge that agreements would be honoured made credit cheap. This was very helpful for promoting the prosperity of our own industry, as in order to extend electric supply a large amount of capital was required at a low rate of interest, and such capital was available in pre-war days for any reliable borrower.

Effects of the War.

Money was cheap in pre-war days because the State and industry lived up to the precept that expenditure must be regulated by income. Then, even the local authorities conducted their internal affairs with a thriftiness which has now become a thing of the past. With the outbreak of war a new era began. It seemed useless to save money when human life was being sacrificed wholesale. The countries involved in the war, naturally, considered that no expenditure was too great to secure victory and this war psychology spread to the whole world. Thus the whole world was dragged into this orgy of spending. For most of the countries engaged in the war this unrestricted expenditure ended in State insolvency concealed by currency depreciation. At first, anyhow, this lavish expenditure of money seemed to benefit industry. Money could be earned with an unheard-of facility. Prices, wages, and salaries rose to a level that had been thought unattainable. The rise in wages and salaries was the necessary consequence of the rise in prices and justified by this increase. At the present day there is a dinsinclination to reduce wages and salaries, although prices have dropped. People will not reconcile themselves to the fact that the times when money was earned easily are over, that the employers of to-day have now to calculate as closely as in pre-war days, and through force of circumstances we have to adapt ourselves once more to times when profits are less. It can, however, be foreseen that workers will have eventually to make far greater sacrifices than those demanded of them now, should it not be possible for us to regain sufficiently soon our position in the world market.

Interference with Industry by the State.

Lavish expenditure by public authorities was not the only evil to be left behind by the war. Another no lesser evil was the interference with industry by the State. In the countries of the belligerents nearly all the industrial activities had to be actually or seemingly nationalised, in order to assure the supply of food and the production of munitions. The State thus acted as dictator of industry and found this function so congenial that it has never been able to divest itself of it. It had been thought that the restrictions imposed on industry during the war would soon disappear after the war, but experience has shown that such things have a dangerous tendency to remain.

Even in pre-war days the tendency to erect tariff barriers was on the ascendant in all countries. The war, however, helped to make this policy supreme. During the years of war, the industrial countries were lacking in foodstuff, while the agricultural countries were lacking in manufactured goods. The industrial countries thus drew as a lesson from the war that they must promote agriculture, while the agricultural countries thought that they must develop manufacturing industries of their own, on a large scale, at all costs. Agriculture and industries that were considered necessary under the conditions of war were rendered profitable at the cost of heavy sacrifices on the part of the State Treasury or of the consumer. Production was increased in all countries, while everything possible was done to keep out goods of other countries. The inevitable result of this policy was a world-wide crisis of a severity such as had never been experienced before. Under the pressure of over-production prices of all world commodities collapsed, and in the case of many goods dropped below production cost. The immediate result of the general fall in prices was an intensification of the protectionist policy. The producers who had got into trouble called the State to their help everywhere, and the State increased again, as far as it could, the protection of industry.

Governments endeavoured to keep up prices or increase them by means of higher tariffs, import prohibitions, exchange monopolies, and subsidies. When all other means failed or proved impracticable, they even had recourse to currency depreciation. The economic conditions that this policy has created are characterised by the fact that the consuming countries of Europe with the largest population have had to introduce meatless and fatless days, while the agricultural countries have a surplus of foodstuff, which they have to dump at cut prices or actually destroy. On the other hand, overseas countries producing raw materials have been trying to manufacture in their countries at heavy cost goods that they could not satisfactorily produce, but that were obtainable from Europe, where these wares could be made cheaply and well; at the same time, they have been dumping their coffee into the sea, and using their wheat as fodder. Things are surely upside down in the economic world.

It is the export industry that is in the worst position with its fetters of State restrictions. The State thinks that it must protect or further the home industries, but it considers that it owes no consideration to the export industries of other countries. Its view is rather that it is of benefit to drive imports off the home market, and seek more expensive substitutes at home. It is only the fear of reprisals by foreign countries that prevent most countries from eliminating imports entirely. When this fear does not operate, the State closes the home market to the industries of other countries without any regard or scruple. Owing to this policy of hostility towards imports, the Swiss export trade has been set back fifty years. Our national income has been reduced by about 2 milliards. Our sales on the world market have dropped from 350 milliard Swiss francs in 1929 to 118 milliards in 1934.

The Evil of Protection.

You will understand that such a situation must cause very grave concern to a company like this one, whose prosperity is intimately linked with the export trade. The protective policy of other countries closes the foreign markets for us or is constantly threatening to do so. Our own protective policy in favour of agriculture and other industries catering for the home market increases artificially production costs. We can reckon, as a conservative estimate, that the protection of agriculture, alone, imposes upon the staff and workmen of the Ateliers de Construction Oerlikon a yearly extra expenditure of 500,000f., which has eventually to be paid out in increased salaries and wages.

The international protective policy further closes for us many markets, even in the countries which are still accessible to us. The Swiss electrical engineering industry would at the present day be well in a position to supply the necessary plant and machines for the electrification of railways in many other countries. Electric traction presents so many advantages in countries poor in coal and of a mountainous character that orders would not be lacking. The railways in all countries are, however, unfortunately going through a crisis, and the end of the crisis cannot be foreseen as long as a protective policy exists. Railways and shipping require a certain minimum amount of freight. If the traffic drops below this minimum there is no longer the return to make the business pay its way. The world crisis has caused traffic to drop below this minimum. The enormous drop in price of most articles of commerce should have brought about a revival of sales and an increase in goods transported. This has, however, been prevented by the protective policy, which has kept away from the country the cheap foreign goods. The shrinkage of traffic is thus artificially maintained for the transport industry. The railways are not in a position to raise the necessary money for conversions to electric traction, as they are not able to guarantee the interest on it. Things are even worse still in the case of shipping. It is so little employed that the shares of many large shipping companies have become worthless. Although the Swiss electrical engineering industry is not so directly affected by the depression in shipping, competition is accentuated thereby, as our foreign competitors, owing to lack of orders in this direction, have to seek outlets elsewhere.

Electricity is the form of energy that has the greatest number of uses. Apart from electric traction, there is also electric supply for power and light that affords a field of application capable of great expansion in the vast areas of the agricultural countries and countries producing raw materials. Unfortunately, the European policy of Protection shuts off this outlet too. As the European industrial countries close their markets in Europe and overseas for the agricultural countries the latter countries cannot sell sufficiently, and can practically make no profit on their export trade. In the agricultural countries, the producers have to accept prices which hardly cover cost of production, and leave no margin at all for renewals and additional expenditure. The farmer in the agricultural countries is ruined in order to maintain the farmer in industrial countries. It is true that the farmers in those countries are not such direct customers of our industries, and it might appear to us that this policy is in itself a matter of indifference. In the agricultural countries, however, the maxim still holds good that if the farmer has money all the world has money, for there agriculture is the main industry. If the farmer does not earn anything, trade, industry, and transport, too, earn too little, and cannot therefore place orders with us.

The industrial countries through their policy are artificially rendering the agricultural countries insolvent, and the inevitable result is that the creditors of the agricultural countries are injured too. Switzerland, in particular, has been hit very badly in this way, as she had lent much money to those countries and her banks have been severely blamed for so doing. This criticism should, however, rather be directed against a policy that has prevented the agricultural countries from creating the money necessary for meeting their obligations, which could only be provided by their exports. To hinder these countries in every way in their exports means to prevent them from paying their creditors. Unfortunately, this has had the effect that the European investor, too, has ceased to want to lend his money to those countries. The further opening up of those countries is thus prevented. They require an inflow of European capital, without which they can develop neither their electric power supply nor their transport facilities. Thus they cannot place orders with our industries, and in this way the detrimental effect of protection eventually recoils on us too.

The menace of Japanese competition, which is so much spoken of, has in itself very much facilitated the European protective policy. The reports from our Consuls overseas confirm that the consumers there have to buy cheap Japanese goods, as they have not got a sufficient outlet for their own products in Europe. Our Swiss goods of high quality, in particular, are too expensive for people whose income has been reduced to less than one-half or one-third by the European trade policy. It is thus easy to understand why our exports to South America, Australia, and India have dropped, since the great fall in prices, by

* Translated from the address by the Chairman of the Ateliers de Construction Oerlikon, at the annual general meeting of the company, held at Zürich on November 15th, 1935.

70 to 90 per cent., while the Japanese exports to those countries have increased by leaps and bounds. It is also easy to understand why these countries have endeavoured to develop their own industries. If Europe does not soon alter its policy these countries will eventually be successful in their endeavours and the European industries will lose their overseas clients for ever.

DUMPING.

As the European industrial countries have ruined their clients, their industries are at the present day suffering from a constant lack of sales. In order to overcome this difficulty they are driven more and more partly to give away their goods. Dumping—that is to say, sales under cost price—is nothing else than partly giving away goods, and such dumping is now nearly the rule in the export trade. Export subsidies have become a practice, which in many cases is no longer even concealed. Our neighbour in the North, that has apparently no money for paying the interest promised to its creditors, has, however, found the money for making a present of a milliard to the foreign buyers of its goods. In certain countries, currency depreciation makes it possible to export below the actual cost to the country's economic system. Currency depreciation conceals dumping, as it transfers the loss to the creditors and to those in receipt of salaries and wages. In our line we have been able to observe again and again that, whether the countries have a depreciated currency or grant export subsidies, they sell as a rule below cost price. In the case of nearly every article subjected to international competition tenders are submitted with prices that do not cover the actual cost.

Dumping applies at the present day, not only to the export of goods. In many countries the foreigner travels on the railways at rates 30 or 50 or even 60 per cent. lower than the inhabitant of the country. Shipping conveys him and his goods at rates involving a loss. The petrol for his car is supplied to him free of tax, and if only one could be a foreigner everywhere it would be a joy to live. Owing to the fact that countries with their protective policy wish to keep out at any price the foreigner when he is a seller, they have to grant him special privileges when he is a buyer. Even this strange paradox is not sufficient to open the eyes of people throughout the world. The power of habit is greater than the power of common sense. Thus the European countries cling to a policy, of which it can be said with mathematical certainty that it will lead them to ruin.

CLEARING AGREEMENTS.

Now that countries have got themselves in this intolerable position by protection they are trying to render the situation bearable once more by resorting to import quotas, compensation arrangements, and clearing agreements. Our experience in the course of business with these measures renders us sceptical concerning them, even if we were not to object to them from the point of view of principle. These restrictive measures can no more replace free intercourse than crutches can replace a sound leg. Losses, disappointment, and a huge amount of useless work, which means a further increase in the already heavy cost of production, are the final results of this restrictive economic policy.

CURRENCY DEPRECIATION.

The latest consequence of Protection has been currency depreciation, that has spread through the world like an infectious disease. Currency depreciation has not brought about anywhere the improvement in conditions that it had been hoped it would achieve. It has, however, been resorted to, as people wished to avoid at all cost the natural way out of the crisis. Shortsighted selfishness, which is at the present day the guiding principle in international trade policy, had thought to bring about through currency depreciation an increase in exports, but is still waiting for the fulfilment of its expectations. The fact had been overlooked that every depreciation in currency hinders as much imports as it facilitates exports.

It is not possible in the long run to increase exports while checking imports. It may be possible to cause certain changes in the direction of the external trade whereby individual industries may benefit; such advantages are, however, always gained at the expense of trade as a whole. Import and export depend upon each other, and it is only possible to increase exports above the level required for paying for imports and for the settlement of other obligations by partly giving away the goods exported. This is rendered possible by currency depreciation; a nation is, however, not enriched by what it receives in return for such exports. If we drive down the value receivable in return for our exports below our production cost, through currency depreciation, we are drawing upon the economic system of the country; under such conditions we can export as much as we like.

On the other hand, currency depreciation has in time rendered long term credit much dearer in nearly all countries, and a depreciation of the Swiss franc would do the same for us. This would be very detrimental to our industries, seeing that a large amount of capital is still required for the extension of electric power supply, as mentioned before, and that electric power supply would, in many cases, not be an economical proposition if the rates of interest demanded were too high.

CONCLUSION.

I have dealt with these matters somewhat fully, not with a view to giving you a lecture on Economics, but in order to let you know our troubles and to show you that we industrialists take a longer view of these matters than that of immediate business interest. It is, unfortunately, a fact, as the Report of the Trade and Industry Association points out, that the authorship of most of the measures damaging to industry lies with industry. In times of depression every class seizes upon anything that may be of momentary benefit. The public is thus strengthened in the belief that the protective policy is necessary and should be extended. It would appear that this is often what our most influential politicians think. Yet, if they think thus, they are mistaken. I am convinced that we have reached the limit of what can, in the long run, be borne and have even exceeded it. The additional burden imposed by this policy increases from day to day, and although we do not know when it will crush us, we know that we cannot bear it indefinitely. The Swiss industry is now in a state of acute depression, which must necessarily have very serious consequences for the nation, if it is not possible to overcome it soon.

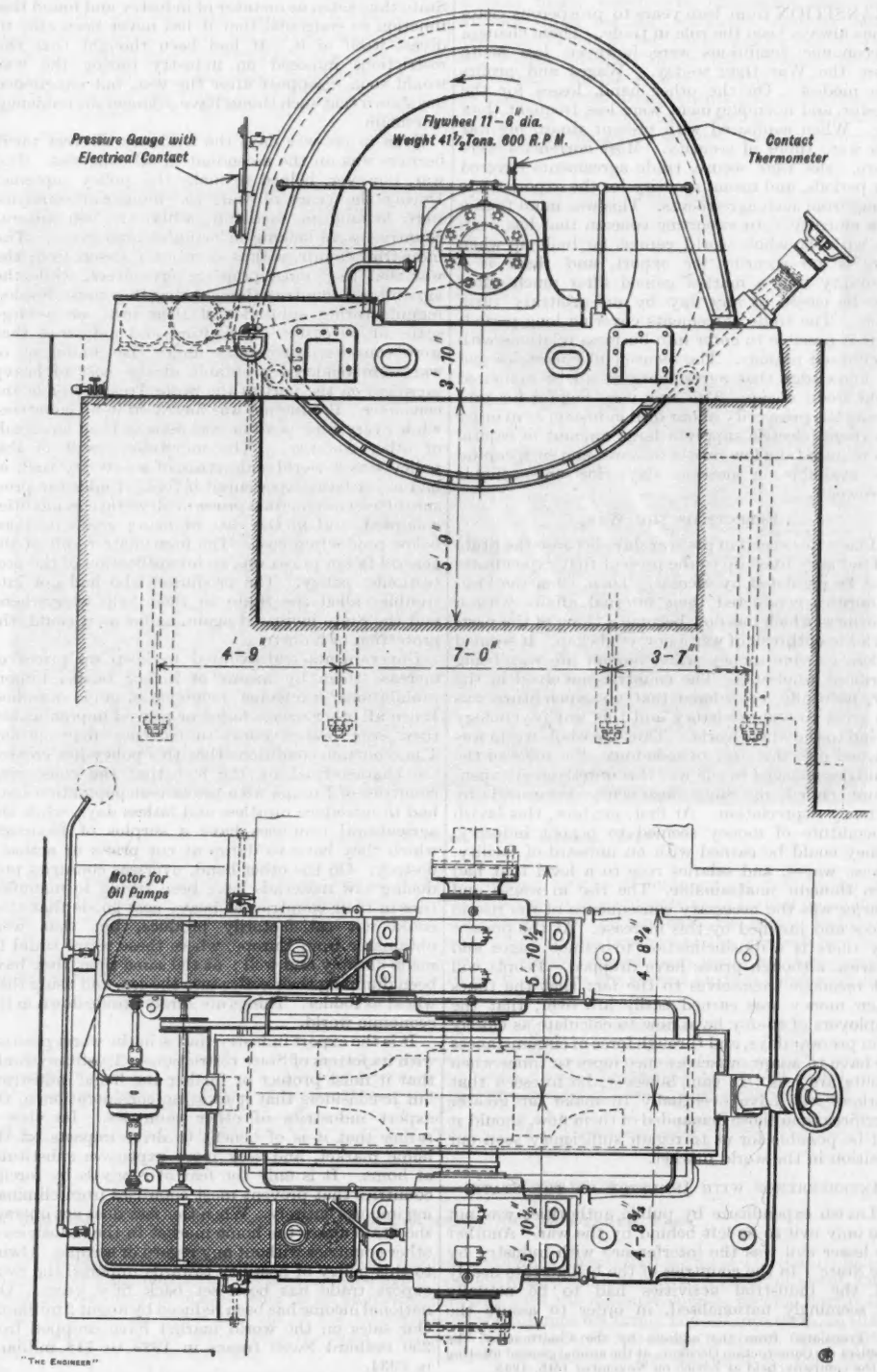
We must not allow ourselves to be led deeper and deeper into the morass through illusions of State help. We must rather strive to recover free intercourse in trade and to bring to an end the restrictive economic system; we must aim at stable currencies, at economy in industry, and in the sphere of public administration; and finally, at a policy of long-term trade agreements with moderate tariffs, in spite of the outcry of opposing interests.

There is in the long run only one effective means of promoting exports—that is, by facilitating imports. It is only when the industrial countries are prepared to buy from the agricultural countries the surplus production of the latter and the agricultural countries to take, in return, the products of the industrial countries, that sound, economic conditions can be restored throughout the world.

High-Speed Fly-Wheel for Rolling Mill.

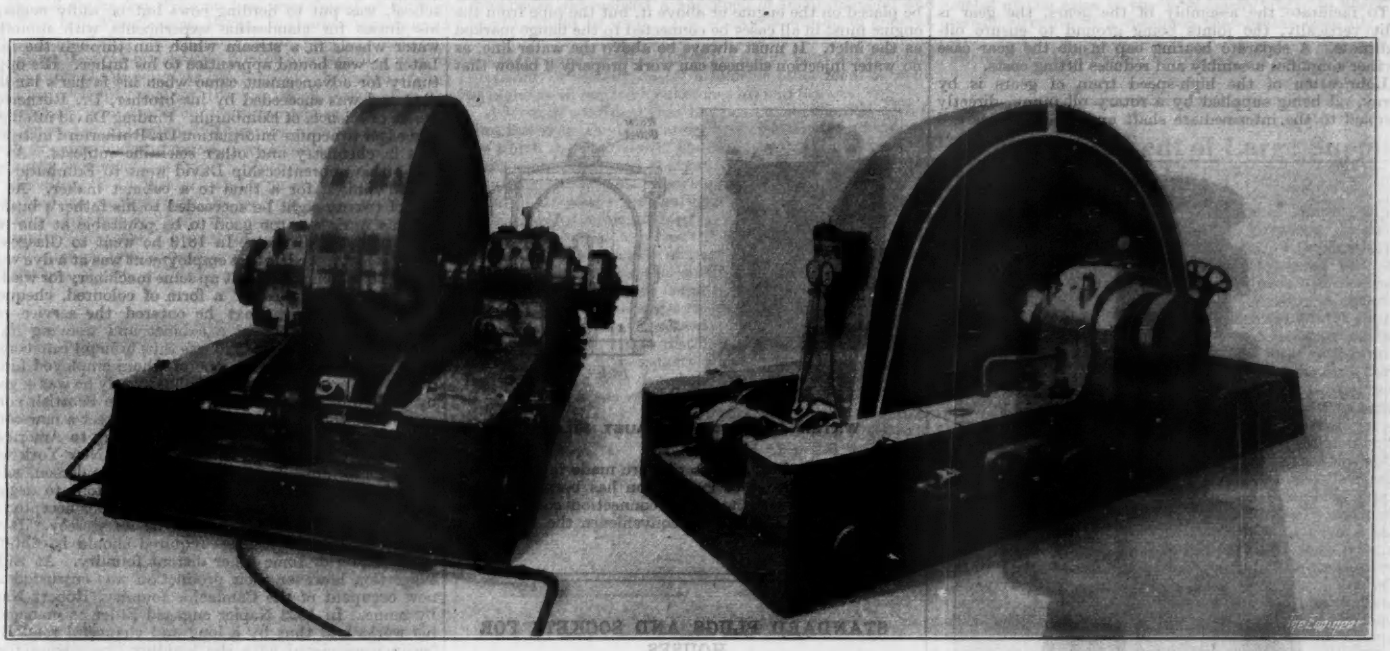
A FEW weeks ago we had the pleasure of seeing under test in the makers' works the high-speed fly-wheel which is illustrated herewith. It was designed and made by Hick, Hargreaves and Co., Ltd., of Bolton, for an electrical rolling mill plant which the English Electric Company, Ltd., is constructing for the new works of the British (Guest Keen Baldwins) Iron and Steel Company, Ltd. The consulting engineers are Messrs. McLellan and Partners. The wheel takes the peak load as the ingot enters the mill, and at the conclusion of the pass speeds up again in readiness for the next. The load on the motor is therefore fairly steady and may be as little as one-fifth of the peak load of the equipment. The arrangement is one now in general use.

The particular fly-wheel we illustrate is 11ft. 6in. diameter and weighs about 41 tons. At 600 r.p.m.



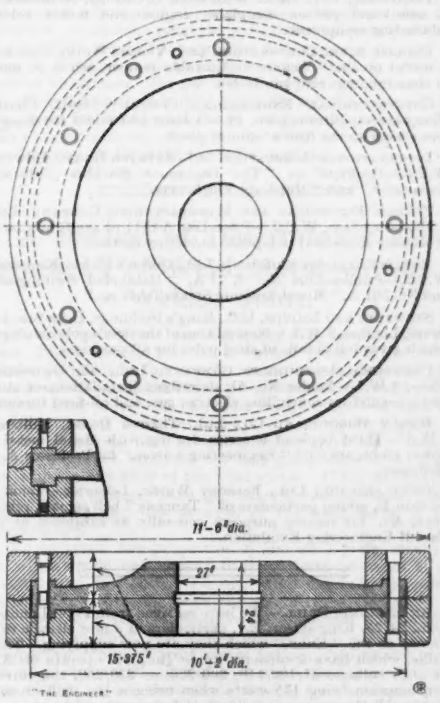
FORTY-ONE TON HIGH-SPEED FLY-WHEEL FOR A ROLLING MILL

HICK, HARGREAVES AND CO., LTD., BOLTON, ENGINEERS



it has a stored energy of 200,000 h.p. seconds and can transmit up to 20,000 h.p. It is made of steel throughout and is built up in the manner shown by the drawing. The method of locking the two rims to the wheel centre to resist centrifugal force will be noticed, and it will be seen that the bolts have no more to do than hold the parts together. The centre is shrunk on and no keys are needed.

Needless to say, balancing of a wheel of this size running at a high speed had to be very accurately carried out. As a matter of fact, it is so accurate that a weight of no more than 1 oz. at the periphery will start the wheel rotating from rest. Remarkable as it may seem, the balancing was carried out with the fly-wheel mounted in its own bearings by a system originated by Mr. W. Burrows, engineer of Scott and Hodgson, Ltd., until



ELEVATION AND SECTION

the closing of that firm, and now with Hick, Hargreaves and Co., Ltd.

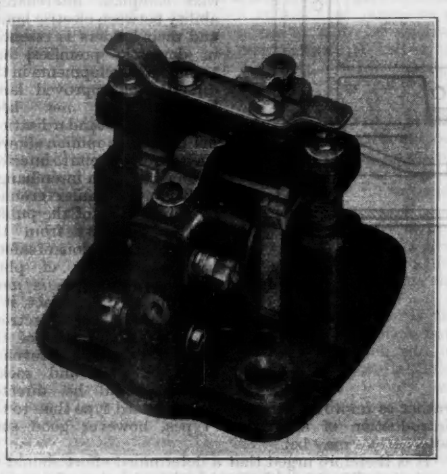
To make it clear how this was possible, it must here be explained that in operation the fly-wheel is oil-borne, oil being continuously pumped into the bottom bearings at a pressure of about 200 lb. per square inch. Frictional resistance is reduced to practically negligible proportions by this method. With the fly-wheel at the overload test speed of 660 r.p.m., we could not detect the slightest vibration.

In the two photographs reproduced the fly-wheel is shown with the cover in place and with it removed. The latter shows the equipment as arranged for test and the former in its finished form in the makers' works. On the right and left of the base-plate there are wells containing the oil pumps, two on each side, one pair driven by the electric motor for starting up and standby, and the other pair belt-driven from the fly-wheel shaft for normal use. All the pumps are of a specially designed and made gear type for high pressure. The gauges on the cover indicate the oil pressure and are fitted with electric contacts which operate an alarm in case of failure of the lubrication from any cause.

Manifestly a fly-wheel of this weight and diameter running at high speed on almost frictionless bearings would take many hours to cease revolving if the load on it were removed. Hence, a band brake has been provided. By slinging the brake under the fly-wheel, as shown in the drawing, it tends to lift the wheel and thereby reduces the load on the bearings, but the motor-driven pumps are always started when about to shut down the fly-wheel. The brake is also used for slight lifting of the wheel and shaft for removal of the pedestal bushes.

New Fractional Horse-power Motors.

THE individual electric drive in industry and the use of electric appliances in the home have created a large demand for fractional horse-power motors which frequently receive less attention than larger machines. It is therefore essential that these small motors should be simple and capable of working satisfactorily for long periods without maintenance or even oiling. Hence, before the range of "Bull Junior" fractional horse-power motors was put upon the market by Bull Motors, Ltd., of Grey Friars Works, Ipswich, research and development work was carried out over a period of two years with the object



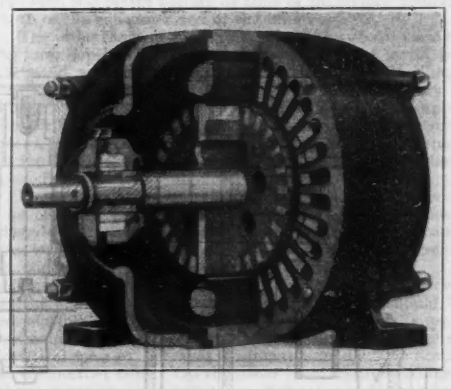
AUTO START UNIT

of producing machines suitable for working under all sorts of conditions, and particularly in places in which the users have no electrical or mechanical experience. The needs of different branches of industry were taken into account and an analysis made of the more frequent causes of trouble, with the result that the new machines now available in sizes ranging from $^1/_{20}$ to $\frac{1}{3}$ h.p. and in the split phase, capacitor, and three-phase types, are both mechanically and electrically suitable for many kinds of duties.

One of the special features of the split phase and capacitor motors is that the starting windings and condensers are controlled by an "auto start unit" instead of the usual centrifugally operated switch inside the motor. This "auto start unit," shown above, consists of a robust contactor enclosed in a small bakelite case, and it automatically adjusts itself to the conditions imposed by the load. It can be mounted in any convenient position away from the motor, and can consequently readily be inspected. Prolonged life tests are said to have shown that the unit can operate for years without renewal of the contacts.

As small motors must usually run silently, sleeve bearings have been standardised, and to enable the machines to run for long periods with minimum attention "Oilite" bushes are employed. "Oilite" is an oil-impregnated bronze material and all surfaces, including those at the ends of the bushes, are continually lubricated. Additional oil is taken up as needed from wool-packed oil wells, and the supply of a few drops of oil after twelve months' normal running is all that is needed. The use of "Oilite" bushes is believed to be new so far as fractional horse-power motors are concerned, but millions of them are said to be in use on other machines. Those fitted to the "Bull Junior" motors have been subjected to abnormal load and temperature without showing signs of seizure or measurable wear.

For driving fans, &c., requiring a relatively light starting torque, a motor is supplied with a condenser permanently



SECTIONAL VIEW OF MOTOR

in circuit, thus obviating the need for an automatic switching device. The machine starts and runs quietly, has a relatively high power factor and low starting current, and the only moving part is the practically indestructible squirrel-cage rotor. A standard ring adaptor enables fan motors to be arranged for three-point suspension, the condenser being accommodated in the motor frame.

For duties involving a high starting torque, as in the case of refrigerator drives, the high-torque capacitor motor with the "auto-start unit" is supplied. It is said that this type of machine suffices for 90 per cent. of the applications for which the repulsion induction motor was previously considered to be necessary. The windings, which are naturally on the stator in all cases, are devoid of joints. Although the paper dielectric condensers employed are more expensive than the electrolytic type, the increased reliability is said to be well worth the extra cost. That the machines are simple and that moving parts have been reduced to a minimum, the sectional illustration clearly shows.

A New Vertical Drive.

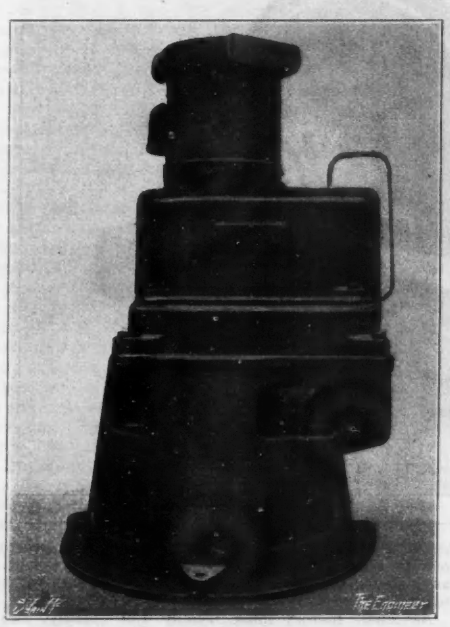
THE double-reduction helical gear unit illustrated has been designed by the Moss Gear Company, Ltd., Birmingham, to provide a highly efficient vertical drive. The section shows the care that has been taken to introduce details that experience with horizontal drives has shown to be essential.

The gears are made from 3 per cent. nickel case-harden-

ing steel forgings, machined all over, the teeth being of single helical form generated by hobbing. The first reduction pinion is overhung on the motor shaft, and the rest of the gears are mounted in ball bearings of the combined thrust and journal type.

To facilitate the assembly of the gears, the gear is split vertically, the joints being ground to ensure oil-tightness. A separate bearing cap inside the gear case further simplifies assembly and reduces fitting costs.

Lubrication of the high-speed train of gears is by spray, oil being supplied by a rotary oil pump, directly coupled to the intermediate shaft and totally contained

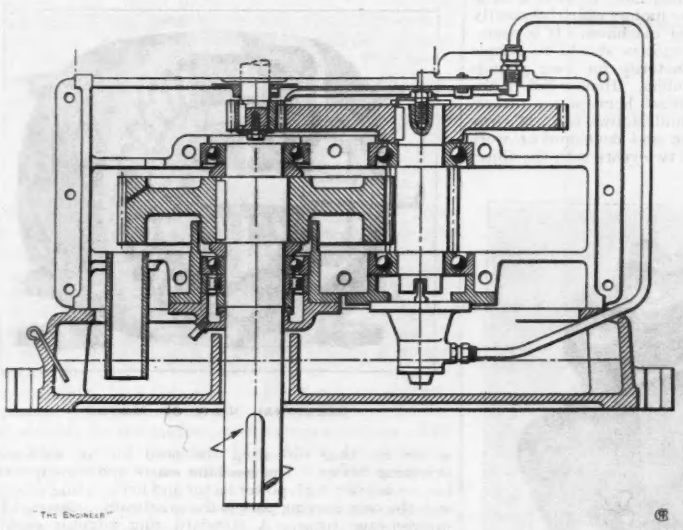


[DOUBLE REDUCTION HELICAL GEAR

within the sub-base, one external oil pipe carrying the supply to the point of engagement of the teeth. The oil then cascades and thoroughly lubricates all the bearings and the second reduction gears before finally collecting in the sump formed by the sub-base.

To prevent oil escaping at the outgoing shaft opening, an inner sleeve is raised inside the gear case at this point, and the oil drains away long before it can reach a dangerous level. An oil thrower rotating with the shaft shrouds this sleeve and deflects the surplus oil into the correct drain channels, whence it passes to the sump.

The half tone illustration shows the unit mounted on a stool, arranged to fit over a large mixing tank. The driving



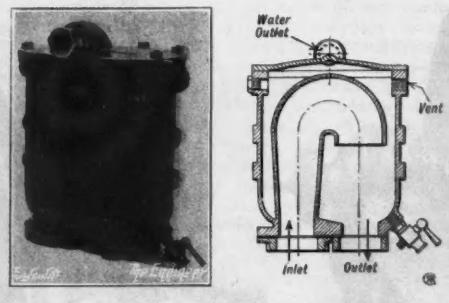
SECTION THROUGH GEAR-BOX

shaft is connected to the stirrer by a pin type flexible coupling.

Owing to the employment of efficient gears and anti-friction bearings, and the absence of gland packings, an overall efficiency of 96% is claimed by the makers. These gear units can be arranged for duties up so 60 h.p.

A Water Injection Exhaust Silencer.

IN the accompanying engraving we show a new water injection exhaust silencer, which has been recently introduced by the Parsons Oil Engine Company, Ltd., of Southampton. The exhaust inlet to the box is in the form of a return bend, over which the circulating water runs, keeping the whole box cool. Thus the water and the exhaust are both moving in the same direction, so that the exhaust exercises an ejector effect upon the water passing down the exhaust pipe immediately beneath it without creating back pressure. At the top of the exhaust box are two connections, either of which can be used for a vent pipe as most convenient. This arrangement renders any vacuum impossible; no water, therefore, can be drawn into the engine. There is a small drain cock at the bottom of the exhaust box, which can be opened as a test, but no water can remain in the silencer, even if the engine should make a few turns after ignition ceases. The silencer can be placed on the engine or above it, but the pipe from the engine must in all cases be connected to the flange marked as the inlet. It must always be above the water line, as no water injection silencer can work properly if below that



WATER INJECTION EXHAUST SILENCER

level. The silencers we describe are made in three sizes, and the convenience of installation has been studied in that the cover with its water connection can be fitted either way round, while for convenience the supporting lugs are duplicated.

STANDARD PLUGS AND SOCKETS FOR HOUSES.

THE British Standards Institution writes that in 1933 it made a widespread inquiry throughout the electrical industry, as the result of which it found an overwhelming majority in favour of complete interchangeability of plugs and socket outlets for domestic purposes. This decision was unanimously endorsed by the Council of the Institution of Electrical Engineers, and in the current edition of the Institution of Electrical Engineers Regulations for the Electrical Equipment of Buildings (commonly referred to as the Wiring Regulations) it is laid down that "every plug and socket outlet shall conform in all respects to the appropriate British Standard Specification."

The reasons underlying the adoption of a plug having standardised dimensions to secure interchangeability and complying with certain safety requirements are broadly :—(i) The convenience of the public; (ii) the safety of the public; and (iii) the convenience of the manufacturers and suppliers who have to carry stocks.

In view of the fact that there are still those who advocate the use of plugs which are non-standard from the point of view of interchangeability, the Electrical Industry Committee of the B.S.I. desires to emphasise the fact that however inherently safe a non-standard plug may be when used with its own outlet, the use of such plugs, nevertheless, introduces a potential source of danger through the mere fact that they are not properly interchangeable with standard plugs.

It is universally agreed that complete interchangeability between electric lamps and their holders is essential in domestic premises, and technical developments in the direction of improved lamp holders have not been restricted by standardisation, nor has public opinion allowed such developments to interfere in any way with interchangeability. On similar grounds of convenience of the public, and quite apart from the above considerations of safety, interchangeability of plugs and socket outlets is more than justified. In fact, it is the view of the Electrical Industry Committee of the B.S.I. that technical development in plug and socket design should be directed rather to improving the existing standard type than to the introduction of alternative types, however good such alternatives may be.

It is therefore urged that a determined effort should be made by all concerned towards the adoption of a rigidly standardised system of plugs and socket outlets for domestic purposes, and that the only plugs and socket outlets to be used to this end should be those complying with British Standard Specification No. 546, Two-pole-and-Earth (*i.e.*, 3-pin) Plugs and Socket Outlets.

SIXTY YEARS AGO.

THE name Elder is still honoured in Clydeside shipbuilding circles in its double association with David, the father, and John, the son. In our issue of December 17th 1875 Mr. John Bourne, continuing his reminiscences, gave a sketch of David Elder's life founded on notes taken down in 1855 from Elder's own lips. We are often struck by the variety of experience, training and attainments of the early pioneers of our profession. In none, surely, could they have been greater than in the case of David Elder. He was born near Kinross in 1785. His father, Alexander Elder, was a country millwright locally celebrated as a constructor of ploughs, a strict member of the Anti-Burgher sect and a mechanical genius whose lack of worldly success had made him intolerant of mechanical innovations. Young David, after leaving school, was put to herding cows but he sadly neglected his duties for clandestine experiments with miniature water wheels in a stream which ran through the farm. Later he was bound apprentice to his father. His opportunity for advancement came when his father's landlord died and was succeeded by his brother, Dr. Rutherford, a man of science, of Edinburgh. Finding David intelligent and eager to acquire information Dr. Rutherford instructed him in chemistry and other scientific subjects. At the end of his apprenticeship David went to Edinburgh and bound himself for a time to a cabinet maker. At the age of twenty-eight he succeeded to his father's business but his work was too good to be profitable at the rates current in the district. In 1813 he went to Glasgow to seek his fortune. His first employment was at a dye works where he was engaged to fit up some machinery for washing and dressing "pulicats," a form of coloured, chequered silk handkerchief. Next he entered the service of a joiner and later that of a cabinet and weaving implement maker at Paisley. He was thus brought into contact with the Paisley spinners one of whom employed him to design and erect a new mill. Subsequently he was engaged by Mr. James Dunlop, a pioneer of the Scottish cotton manufacturing industry, to design and erect a new cotton mill. He was on the point of proceeding to America to build a cotton mill for Mr. Dunlop near New York when he was recommended to Mitchell and Anderson, silversmiths of Glasgow as a mechanic competent to design a machine for stamping silver spoons. Elder accepted the task a feature of which was to be its secrecy. It was proposed that the castings required should be obtained from Carron or some other distant foundry. At Elder's suggestion however their production was entrusted to a new occupant of the Camlachie foundry, Robert Napier by name. In 1822 Napier engaged Elder as manager of his works and thus by a long and chanceful road Elder became associated with the budding Clyde shipbuilding industry. It was with Elder's help that Napier entered the marine engine field and soon Napier's engines in hulls built by John Wood became widely famous. David's son John, it may be added, was trained at Napier's works and in due course established a marine engineering and shipbuilding firm in partnership with Charles Randolph, of Glasgow.

CATALOGUES.

D.P. BATTERY COMPANY, Ltd., Bakewell, Derbyshire.—Two new publications, "Kathenode Traction Cells" and "D.P. Dualode Batteries."

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester.—Particulars of models "T W A" and "T W R" roll grinding machines.

TECALEMIT, Ltd., Great West-road, Brentford, Middlesex.—A new catalogue on aeroplane engine and motor vehicle lubricating equipment.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield. A leaflet on the "Vickers" adjustable reamer, which is made in sizes ranging from ¼in. to 6in.

CONSTRUCTIONAL ENGINEERING COMPANY, Ltd., Charles Henry-street, Birmingham, 12.—A loose-leaf folder for descriptive sheets on the firm's foundry plant.

INTERNATIONAL COMBUSTION, Ltd., Aldwych House, Aldwych, W.C.2.—Booklets on "The Beaumont Slackline Cableway Excavator" and "Hardinge Thickeners."

FULLER ELECTRICAL AND MANUFACTURING COMPANY, Ltd., 5, Chancery-lane, W.C.2.—Price List A C 11 of the firm's range of smaller single and polyphase induction motors.

ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C.2.—Publications No. K 71 A, "Metal-clad Switchgear," and No. 561 A, "Mixed-pressure Steam Turbines."

STEWARTS AND LLOYDS, Ltd., King's Buildings, Dean Stanley-street, London, S.W.1.—New edition of the firm's pole catalogue, which gives full details of steel poles for all purposes.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., 45, Grosvenor-place, S.W.1.—Folder No. 51, describing installations of automatic regulators controlling electric, gas, and oil-fired furnaces.

HENRY WIGGIN AND CO., Ltd., Thames, House, Millbank, S.W.1.—Third book of a series dealing with Monel metal in power plant, entitled "Engineering Valves," by Professor A. L. Mellanby.

GENT AND CO., Ltd., Faraday Works, Leicester.—Book 7, Section B, giving particulars of "Tangent" bell signals, relays, keys, &c., for mining purposes generally as exhibited at the Cardiff Engineering Exhibition.

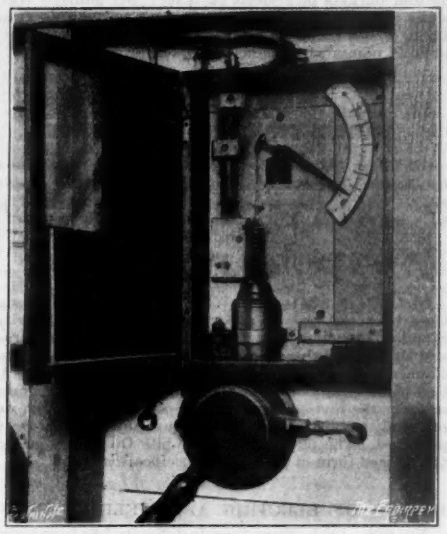
AN ELECTRIC DRILL.—We have received from Frys (London), Ltd., 24/25, King-street, E.1, particulars of a new electric drill, known as the "Enox," which they are now supplying. These drills, which have a capacity up to ¼in., will operate on A.C. or D.C. voltages of 100/110, 200/220, or 230/250, the current consumption being 175 watts when using a ¼in. drill on mild steel. All the gears are hobbed and are enclosed in a grease-tight metal housing. The main shaft is fitted with a Hoffmann ball thrust, and the die cast aluminium handle is designed to enable the drill to be used and controlled with ease.

AN EXCEPTIONAL DINNER.—On Thursday, December 12th, we were at one of the most delightful dinner parties that we have attended for a long time. From force of habit we use the editorial "we," but, as a matter of fact, there was no Press and the dinner was just a private party on a very large scale. There was not even a top table, and there were no official speeches. The occasion was the Silver Jubilee of the Superheater Company, Ltd., and the guests were welcomed by Mr. Alex. Spencer, the chairman, and Mr. Eric Robinson, the managing director. They had collected their friends around them to celebrate their twenty-fifth birthday. Needless to say, the railway world was well represented, but so was marine engineering and power supply. We say there were no speeches, but Mr. Spencer did say a few words of welcome and Mr. Lemon replied for the guests, and somebody proposed the health of Mr. George Bourne, chairman of the American company, and somebody else proposed Mr. Spencer's health, and everyone sang "For he's a jolly good fellow," whilst the band persisted in playing what we imagine was the "signature" tune of somebody's cabaret which took the floor at that moment and sang its own chorus. A thoroughly happy and charming birthday party on which the Superheater Company is to be congratulated as heartily as upon its Silver Jubilee.

An Old Electric Lighting Plant.

AN old Crompton dynamo has been found at Sulham Rectory, near Pangbourne, Berks. It charges the accumulators for lighting the eighteen-roomed rectory and outbuildings, and with the exception of Sundays has been in regular use throughout its life for from five to six hours each day. Unfortunately, the fire which occurred at the Chelmsford works in 1895 destroyed the records of early machines, but it is evident from the number and design that this particular dynamo was built before 1888 and probably in 1885.

The Rev. H. C. Wilder, who lives in the rectory, has informed the makers that the electric lighting plant was installed by his brother, who was a pupil of Colonel Crompton. He was also responsible for the construction of the solenoid type ammeter shown in the accompanying illustration. The oil dashpot is apparently composed



SOLENOID TYPE AMMETER

of an ink or similar bottle, but it serves the purpose for which it is intended. Immediately below the instrument is the main switch.

The dynamo, which is marked 5½in. by 10in. to indicate the armature core dimensions, is now belt-driven by a comparatively modern Petter engine, which has taken the place of an ancient machine with flame ignition provided by a spirit lamp. Occasionally the dynamo betrays its age by displaying slight excentricities, which is not altogether surprising. Oil has a tendency to run through the bearings faster than it did originally and the commutator has been known to work loose. But, on the whole, after fifty years' service, the machine works remarkably well, and appears fit for another spell of service.

A Method of Determining the Strength of Weld Metal within a Welded Joint.*

FOR several years the Company has emphasised the fact that a tensile test on a welded joint, unless made under particularly favourable circumstances, does not give information on the intrinsic properties of the weld metal within that joint. In fact, the result may well deceive. A low strength weld metal may be held up by a plate of higher strength, and in consequence show an elevated tonnage, and at any rate the test gives little or no guidance on the ductility of the weld metal. If the weld metal is of higher strength than the plate, the failure takes place in the plate and the strength of the weld metal is not ascertained.

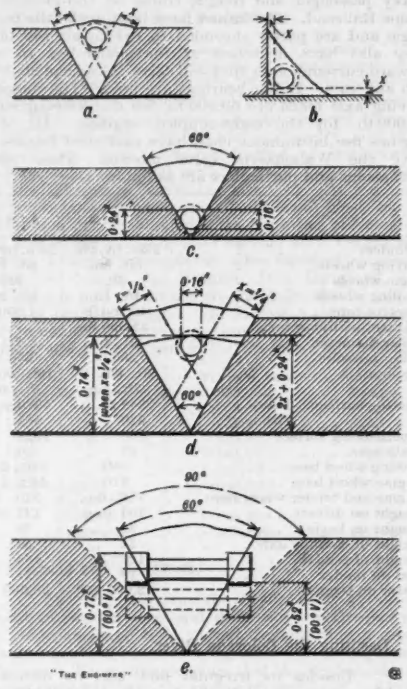
To ascertain the properties of the weld metal itself, it is necessary to have resort to some form or other of all weld metal test bar. Though with carefully prepared samples it is possible with the majority of electrodes to lay the metal in such samples in a manner comparable with that in which it is laid in a butt weld, when the test properties of the all weld metal bar are comparable with those at the middle of the butt weld, this is not always practicable, and in commercial testing sufficient care may not always be exercised in the preparation. An objection that has sometimes been raised to all weld metal test pieces is based both on the foregoing reasons and on the possibility that, while the metal within a butt joint may be benefited by admixture of the parent metal, such benefit is not imparted to the all weld metal bar. Though when large-sized specimens are required it is hardly possible to avoid testing by means of specially prepared samples, by use of small-sized samples it is possible to overcome these objections and obtain the required information within reasonable accuracy by a cheaper and more expeditious method. By such means, the properties of weld metal are determinable when all weld metal samples are not available, with the advantage that the test will always be made on metal from an actual joint.

The method of testing weld metal by means of tensile specimens of standard size cut out longitudinally from welded joints is not new. This, however, except for thick joints, involves the preparation of welds of special profile, in order to accommodate the specimens, and at the same time avoid abnormal admixture of the parent metal. In addition, such a weld is comparatively expensive to prepare, and the runs of metal are likely to be laid very differently from those in the actual joint.

The present suggestion is that for laboratory tests and perhaps occasionally for commercial tests in which the drawbacks are realised a specimen of small diameter and length should be used. The thickness would, in general, have to be such that the specimen can be cut longitudinally out of the weld metal contained in a butt joint not specially prepared, or equally out of a fillet or other form of weld, as is shown in section by sketches (*a*) and (*b*).

A form of specimen that has been experimented with is that tested by the apparatus of the Tensometer Company, for which the diameter of the test length may be made as small as 0·16in., and the gauge length is approximately equivalent to $4\sqrt{A}$. The length of this specimen is so small that, where necessary, a scrap end of a weld can furnish useful information.

As the specimen involves the use of a special apparatus, and as, in the absence of particular care, inaccuracy is likely to creep into the small measurements involved, such a form of specimen is hardly suitable for standardisation. It is to be pointed out, however, that the diameter may, if desired, be increased to 0·226in., but even the smaller specimen has a distinctly useful field of application. Lack of homogeneity in the small area involved may sometimes be a drawback, but where necessary can, of course, be largely remedied by an increase in the number of specimens tested. Beyond this, the specimen suffers from the disadvantage common to most forms of all weld metal specimen, *i.e.*, that the runs of metal are tested longitudinally, not transversely. The load on a specimen



cut longitudinally is, of course, applied at right angles to the load of service, and, as a test, should show up weakness due to slag or imperfect cohesion at junctions or between neighbouring beads in line with the stress, testing transversely is preferable on principle. Whether the result of a test in a particular direction is worse or better, will naturally depend on the actual method adopted in laying the runs.

On the assumption that the weld metal has benefited from admixture of the parent metal, a specimen cut out of a part removed as far as possible from the junctions, *i.e.*, from the position where the distance x is as large as possible, represents truly the weakest part of the weld metal.

As is required with any form of all weld metal sample consideration must always be given to the state of heat treatment of the particular portion of the weld from which the sample is cut; that is, if the test is to represent any particular run of the weld metal.

From sketch (*c*), where the original preparation of the plate is shown and $x=0$, it is to be seen that, with a butt weld enclosing 60 deg., this form of specimen can be used when the plate has a thickness of about ¼in. only, or equally when the height of the lower runs is only ¼in., the top run of metal can be avoided. Such specimens would, however, contain a maximum amount of admixture from the parent metal. The degree of admixture and the depth of the mixed metal will always depend on the method of welding, but if, to avoid appreciable admixture, a minimum value is assumed for x, the minimum thickness of the plate in inches required to accommodate the specimen —see sketch (*d*)—is determined from the expression $2x+0·24$, where x is expressed in inches. Even if the appreciable figure of ¼in. is assigned to x, it is to be seen that the test length is clear of the top run of metal, when the height of the lower runs reaches about ¾in.

No rule can be laid down, whether a specimen should be cut from the upper or the lower runs. This will depend on circumstances and the judgment of the tester. As has been pointed out in previous reports, the usual specimen for testing a butt welded joint comprises a certain amount of top run metal, and comparative results are therefore obtained only if both sets of samples are heat treated simultaneously above the upper critical range and cooled at the same rate.

As an alternative, when the plate reaches ¾in. (or less for an angle of V greater than 60 deg.), the longitudinal axis of the specimens can be made to lie in the line of the stress of service, as is shown by sketch (*e*), when the specimen occupies a still smaller length of weld run. By this method the top portion only of the weld can be tested but this may be of no moment if the desire is to test the least adulterated or the coarsest part of the weld metal. With this method any abnormal admixture of the parent metal at the sides of the V is hardly likely to affect the tensile strength of a specimen that breaks centrally, and with a central break the ductility is not likely to be altered thereby by more than a few per cent.

* From the Technical Report for the years 1933–34 of the British Engine Boiler and Electrical Insurance Company, Ltd.

The Measurement of Large Supplies of Electrical Energy.

IN a paper on "The Measurement of Large Supplies of Electrical Energy for Costing Purposes," read by Messrs. W. Casson and A. H. Gray before the Institution of Electrical Engineers on Friday, December 6th, it is suggested that for large supplies accurate estimates should be made of their cost to the supply authority so that comparisons can be made with the actual charges to check the accuracy of tariffs. A scheme outlined for ascertaining the true cost takes into consideration such difficult items as diversity and power factor. Owing to the increasing quantities of electricity that are being sold, and to the fact that the profit factor generally decreases as the load rises, these considerations are yearly becoming of greater importance. From a superficial examination it appears to the authors that a scientific tariff should be applied so that a consumer may be charged in accordance with the direct effect upon the bulk supply, automatic provision being made for diversity and power factors, &c. Unfortunately, in most cases, such a tariff presents difficulties, both in application and measurement. In practice it is usual to approximate the accuracy of such a tariff by the use of empirical factors, but while the tariff may be economically sound when initiated, considerable errors may arise if the nature of the loads, both of the consumer and of the supply authority, vary to any large extent. The verification of these empirical factors from time to time is therefore considered to be just as important as the usual routine tests made to arrive at metering accuracy, and one of the objects of the paper is to suggest a method of making these checks. While it is realised that frequent tariff changes would meet with opposition, it is felt that an accurate knowledge of the cost of supply is essential when allocating tariffs for future consumers.

Usually modern tariffs are a combination of one or more of the following charges:—(*a*) A kWh charge; (*b*) a kW maximum-demand charge; (*c*) a power-factor correction to the kW maximum-demand charge; (*d*) a fixed charge. It is suggested that the variable factors used in such tariffs are empirical approximations only, for the following reasons:—(1) The distribution costs and bulk supply costs are generally combined, whereas it would be more accurate to separate them since they are affected by the nature of the consumer's load in different ways. (2) It is usual to regard the demand charge as a function of the consumer's load only, without any correlation to the bulk supply demand; actually, this diversity factor should be included in an accurate tariff. (3) Most power factor clauses ignore the relationship between the power factors at time of maximum demand, both of the consumer and of the bulk supply.

The importance of the errors, due to the above variable factors, depends upon the construction of the tariff, but it would appear that the values of these factors should be checked periodically. Hence it becomes necessary to check the true cost of the consumer's load to the supply authority. The method given to obtain this measurement, whilst not being devoid of errors, is, in the opinion of the authors, a practical solution to the problem without introducing serious complications.

It is considered essential to divide all the items of cost of the supply to a consumer into two separate sections, distribution and production. This is necessary because the two sections are affected by the time of occurrence of the maximum demand in a different manner. For example, a consumer whose maximum demand occurs at the same time as that of the bulk supply, should be responsible for a greater portion of the bulk supply maximum-demand charges than a consumer with an identical load except that his maximum demand occurs at some other time. On the other hand, both consumers should pay equal amounts towards the cost of distribution, since they load the distribution plant to an equal degree.

As the first essential of an equipment suitable either for measuring a simple tariff or for ascertaining the cost of consumer's load is accuracy, the possible sources of error with the type of equipment necessary are discussed in detail. The measurement of kilowatt-hours, maximum demand, power factor, and reactive kVA demand, is considered, and a new type of kVA meter is described.

American Engineering News.

American Construction Progress.

BUSINESS in general and in the construction industry in particular, in the United States, is making definite progress in spite of interference, mismanagement, and conflicting policies of politicians, amateurs, bureaucrats, theorists, and well-meaning incompetents. However, under such conditions it is still uncertain whether the progress will be maintained. During October, contracts for engineering construction work averaged nearly £8,000,000 per week, with £5,400,000 per week as the average from January to the end of October. While the great relief works fund is most conspicuous, there has been also—and independently—a marked revival in private construction enterprise. In this latter, both industrial building and domestic housing are making great advances, though their totals are still far below normal. This gain in private construction represents a gain in issues of private investment capital that began in 1934, but has increased in strength during 1935. With £320,000,000 for non-governmental construction this year, or £480,000,000 for both governmental and non-governmental new capital

available, it is considered a conservative prediction that the upward trend in general volume of construction will continue. In 1934 the corresponding sums were £195,000,000 and £232,000,000. In industrial building alone the record shows that while in 1934, starting from zero in January, the figures rose steadily to a total of £16,000,000 at the end of October, or £21,000,000 at the end of December, in 1935 the figures had reached £30,000,000 at the end of October, and were still rising. Thus more money is available from private and public sources. There is a good increase in private construction, particularly in industrial buildings and residences; while public construction is maintaining its position. This increase in constructional activities is naturally resulting in increased movement of materials, with resultant benefit to manufacturing industries and transportation.

Large American Convention Hall.

Many large cities in the United States provide municipal auditoriums or convention halls for conventions, sports, exhibitions, opera, and various entertainments. The structural design of such buildings presents difficult engineering problems, especially owing to the requirement for large spaces entirely free from columns, and often having side galleries. In the new auditorium at Kansas City the main floor has a space 225ft. by 190ft. with no column supports for the roof, while beneath it is a space 200ft. by 85ft., in which there are no columns supporting the floor. For the roof there are four braced columns or towers at the corners of the clear area, and these carry two trusses of 226ft. span and two of 190ft. span. The larger trusses also carry nine intermediate trusses of 190ft. span, upon which are laid the rolled steel joists of the roof framing. Each of the 226ft. trusses weighs about 240 tons. For the floor support there is girder framing of reinforced concrete. The two main longitudinal girders, 86ft. apart, are 6ft. deep and 2½ft. thick, built continuously on concrete columns 26ft. between centres. Between these longitudinal girders are cross girders of 85ft. span at intervals of 6½ft. These cross girders are the full depth of 6ft. at their junctions with the longitudinals, and taper to 4ft. in depth. Beyond the longitudinals the cross girders continue at 6ft. depth for an adjacent span of 21ft. All these girders, together with the 4½in. floor slab which they carry, were poured as a monolithic structure, vibrators being used to ensure density of the concrete mass. The columns supporting the longitudinal girders are 3ft. square. In the auditorium galleries are carried by cantilever girders, as is common in many modern theatres. The building is 426ft. long and 352ft. wide, comprising the auditorium proper, with seating capacity for 14,000 people, and a theatre seating 3000. There are also smaller halls, accommodating from 20 to 400 and 1000 persons, for committee meetings and the smaller class of organisations. Temperature is regulated by means of an air conditioning plant having a capacity of 625,000 cubic feet of air per minute.

Wrought Iron in Modern Use.

Although steel has to a great extent superseded wrought iron, the latter still has a definite field owing to its special characteristics, and American manufacturers are improving its quality and reducing its cost with the aid of mechanical methods and metallurgical study. With this has come a revival in interest in this modern material, following a period when it seemed hopeless to compete with steel. At one of the large plants, producing nearly 1000 tons daily, the pig iron is melted in cupolas and charged into 10-ton Bessemer converters to be refined to the required low metalloid content. Here it is intended to replace the cupola with a blast-furnace, for delivery of the molten metal directly to the converters. In the ladle for charging the converters desulphurisation is effected with soda ash, giving a normal sulphur content of 0·03 per cent., or lower if so specified. The iron silicate slag is melted in two basic-lined oil-fired tilting open-hearth furnaces. From the converters the refined iron is poured into a vessel of slag, which is at a temperature well below the freezing point of the iron. The product is a spongy ball of iron, impregnated with the liquid slag. The pouring is done at the rate of 1 ton per minute, and the blooms weigh an average of 5 tons. Pressing and rolling reduce the blooms to billets or slabs, the processes conforming to ordinary rolling mill practice. Most of the product, such as skelp and plate, is rolled from solid sections, as in steel manufacture, rather than from piles of muck bars, as in the older practice of wrought iron production. While analyses of wrought iron give the metalloid content of the composite material, it is desirable to give the distribution for the metal and the slag separately, and methods have been worked out for determining this distribution. With the older puddling process alloy base metals could be added only in the preliminary stages and remained unaffected by the oxidising influences in refining. In the new process, however, the range is much extended, so long as the alloy addition does not affect the plastic welding properties of the sponge ball. As yet the field of alloy wrought iron is almost unexplored.

American Machine Tool Exhibition.

The highly satisfactory exhibition at Cleveland, lasting ten days—with one "Railroad" Day—included 240 exhibitors, more than half of them being manufacturers of machine tools, while the others had special devices or appliances. There were some 900 machines, with 600 in operation, requiring a total of 6500 h.p. Increased strength and rigidity were prominent in many designs, in order to permit full economic use of new cutting tools. Besides an increase of weight for this purpose, there were definite changes in design, as in the elimination of overhanging elements, so that stresses are carried directly down to the bed. Many of the machines also had high ranges of speeds and feeds, with a view to the coming use of special steels for tools. Hydraulic chucking is increasing in favour, as is the use of ground gears to reduce both wear and noise. Numerous designs of grinders evidence improvements in economy and finish, and also the developments in the application of grinding to new types of work. Milling machines, large and small, showed notable improvements in ease of control, greater power, and more efficient cutters, all tending to reduction in cost of work. Control developments were of high importance. Electric and hydraulic methods in combination provide effective remote control of moving elements, the former being the better adapted for control over comparatively long distances. The use of hydraulic, pneumatic, mechanical, and electrical control greatly reduces the operating time, so that in many cases the time of machine operation is less than that of setting up the work and changing tools between operations. Even for large machines every movement or function can be controlled from a single position or station. Increases in cutting speeds were remarkable in some cases, as in automatic screw machines. While all these improvements, including lubrication, anti-friction bearings, &c., tend to greater efficiency, greater precision, and quality of finish, lower maintenance cost, and greater service life of the machine, they bring up the question of training or educating the operators, as the high speed and short time of operation necessitate continual concentration on the work. Welded construction is increasing for special parts not made in quantity, and nickel-iron alloys are being largely used for castings.

New American Locomotives.

While oil and oil-electric locomotives and specially built trains continue to increase, they are as yet but a small percentage of railway equipment, and hardly affect the continued building of new and more powerful steam locomotives. Among recent engines are some 4 : 6 : 2 and 4 : 8 : 2 engines for high speeds with heavy passenger and freight trains on the Boston and Maine Railroad. The former have boosters on the trailing bogie and are partly shrouded to reduce air resistance; they also have deflectors at the smoke-box to cause upward currents of air that will carry the smoke above the cab and cars. Roller bearings are used. The maximum driving axle loads are 69,900 lb. for the six-coupled and 68,900 lb. for the eight-coupled engines. All of the engines use bituminous coal, have cast steel frames, and have the Walschaerts valve motion. Their leading dimensions and particulars are as follows:—

	4 : 6 : 2.	4 : 8 : 2.
Cylinders	23in. by 28in.	28in. by 31in.
Driving wheels	6ft. 8in.	6ft. 1in.
Bogie wheels	3ft.	3ft.
Trailing wheels	4ft. 1in.	3ft. 2in.
Tractive force	40,900 lb.	67,000 lb.
Ditto, with booster	52,800 lb.	—
Boiler diameter	6ft. 4in.	7ft.
Boiler pressure	260 lb.	240 lb.
Fire-box	9ft. 6in. by 7ft. 1in.	10ft. 6in. by 7ft. 6in.
Heating surface: Tubes	3848 sq. ft.	4070 sq. ft.
Fire-box	320 ,,	474 ,,
Superheating surface	966 ,,	1924 ,,
Grate area	67 ,,	79 ,,
Driving wheel base	14ft.	19ft. 3in.
Engine wheel base	37ft.	44ft. 2in.
Engine and tender wheel base	77ft. 6in.	92ft. 8in.
Weight on drivers	104 tons	135 tons
Weight on bogie	32 ,,	39 ,,
Weight on trailing axle	34 ,,	34 ,,
Weight of tender	120 ,,	185 ,,
Coal on tender	18 ,,	21 ,,
Water on tender	12,000 gall.	20,000 gall.

Desilting the Colorado River.

Besides its irregular flow and its devastating flood flows, one great difficulty in dealing with the Colorado River is the enormous volume of silt which it carries. This is of importance in the operation of the new irrigation canal which heads in the river near Yuma, diverting about 15,000 cubic feet per second. The great Boulder and Parker dams will not have much effect, as the river will pick up silt in its course below the dams. It is estimated that a volume of about 60,000 tons of silt daily must be removed from the water entering the canal. For this purpose there is an extensive equipment of desilting basins having revolving scrapers to remove the silt deposited in the basins. With a present diversion of 12,000 cubic feet of water per second, the silt will amount to 60,000 tons of a size coarser than 300-mesh, but the works are designed to handle 90,000 tons daily. The velocity of flow in the basins is about 3in. per second, with a detention period of fourteen minutes. The plant consists of six settling basins, 270ft. by 770ft., each having a group of rotating scrapers 125ft. in diameter. The scrapers of the first row, which remove the heavier silt, are operated by electric motors of 7½ h.p., while those of the second row have 5 h.p. motors. Each machine consists of a 125ft. truss, revolving on a central pier or pedestal and having attached below each arm a series of curved blades which sweep the silt into circular ridges moving successively towards a circular trench, from which the silt is flushed to a sluiceway with discharge into the river. The revolving element is supported on a circular ball bearing or ring 10ft. in diameter with 1½in. balls, all bearings being above the water on account of the silt. A train of gears of alloy steel reduces the motor speed to a peripheral speed of 30ft. per minute for the revolving arms. Water from the river enters the influent channel at four rolling gates, 14ft. in diameter and 23ft. high, the velocity of flow being 6ft. per second.

Concreting the Wheeler Dam.

The General Wheeler Dam, now being built on the Tennessee River by the United States Bureau of Reclamation, is about 6000ft. long and 50ft. high, of concrete construction, surmounted by gates for regulating the overflow. It will require some 700,000 cubic yards of concrete. The cement used is of the low-heat type, ground so fine that 98 per cent. will pass a 200-mesh sieve. Sand and gravel for the aggregate are taken from the river, at about 50 miles above the dam, by a ladder dredger having buckets of 4½ cubic feet capacity and delivering about 400 tons per hour. About 1,200,000 tons will be required. On the dredger is the crushing, washing, and screening plant, delivering three sizes, 1½in. to 3in., ¾in. to 1½in., and ¾in. The sand is drained and delivered to a barge, two barges being loaded with the screened gravel and sand. The dredger is a steamer, with oil engine and generator supplying current for the pumps, screens, and other machinery of the screening plant. Concrete is made on four floating plants, which are shifted as required by stern-wheel towboats, which also handle the gravel barges, 135ft. by 28ft. and 8ft. deep, each with a capacity of 750 tons. Both steam and oil engine towboats are used. Each concreting barge is of steel, 90ft. long and 40ft. wide, with a switchboard that is connected with an electric cable laid along the cofferdam, the current being transformed from 2300 to 440 volts. Four spuds or piles hold the barge in position and are handled by the 75ft. jib crane on the barge. Sand and coarse aggregate are supplied by two barges moored on either side and unloaded by the crane with a 2-yard grab bucket. Moored to it also is the cement barge, from which the cement—in bulk—is pumped through a 4in. pipe. From the elevated bins the cement and aggregate are fed to an automatic weighing machine, which weighs out the proportions of the several sizes of aggregate for each batch of concrete. From the mixer the concrete is discharged automatically into drop-bottom buckets of 2 yards capacity. Six gantries travel along the cofferdam, each carrying a revolving jib crane. These cranes handle the buckets and the gantries deliver them at points where concreting is in progress.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

WHITE PIGMENTS AND OIL PASTES FOR PAINTS.

Nos. 239 and 241—1935. The Institution has for some time been engaged in a review of the existing British Standard Specifications for Paints and Paint Materials, and the issue of these two publications, one entitled White Pigments and the other White Oil Pastes, represents the first of the revisions. The publication for White Pigments includes the revised form of five Specifications which were originally published separately. It is obtainable at 3s. 8d. post free. The publication for White Oil Pastes includes the revised form of three B.S. Specifications.

RATING OF ELECTRIC ARC WELDING PLANT.

No. 638—1935. Considerable difficulty has been experienced in the past owing to the differences that have existed in the method of rating electrical equipment used for welding purposes. Because of the intermittent nature of the load and the conditions of working to which the plant is subjected, the standard method of rating electrical equipment for general engineering purposes is not applicable, and any attempt so to do would place a serious handicap on the industry. It would result in the use of unnecessarily heavy equipment, and as ease of transport and portability are essential factors in this work, it is desirable that the plant should be as light as possible. This new Specification standardises the method of rating metal arc welding equipment. The specification is in two sections. The first lays down the rating for welding sets of the non-automatic and automatic type, and also of the single and multiple-arc type, electric motors, reactors, transformers, and resistances. The second section deals with safety appliances, and lays down requirements for welding accessories, such as electrode holders, hand shields, helmets, screens, gloves, aprons, and similar equipment.

COVERED AND BARE ROD ELECTRODES FOR METAL ARC WELDING.

Nos. 639—1935 and 640—1935. These specifications provide for electrodes suitable for welding wrought iron or mild steel not exceeding 33 tons per square inch, and in each specification there is a range of grades appropriate to the class of work to be carried out. In the Specification for bare wire electrodes, there are three grades which are differentiated by the chemical composition of the wire. In the Specification for covered electrodes, there are four grades which are differentiated according to the mechanical properties obtained from all-weld-metal test pieces. No chemical composition, either of the core wire or of the flax covering is specified for covered electrodes, but a clause on strength and stability of the coating is included.

SMALL RIVETS FOR GENERAL PURPOSES.

No. 641—1935. British Standard Specifications for the form and dimensions of rivets have hitherto been confined to structural and boiler rivets, ½in. in diameter and upwards. Large quantities of rivets under ½in. in diameter are used industrially for many purposes, having forms and proportions which differed greatly and for which no recognised standard existed. In response to strong representation a representative committee has now formulated an agreed standard for rivets under ½in. diameter. The new specification is dimensional only. Following the custom of the trade, five forms of rivet head, snap, pan mushroom, flat and countersunk are common to both ferrous and non-ferrous metals, two countersunk heads are confined to non-ferrous and another to ferrous metals.

250-VOLT CARTRIDGE FUSES.

No. 646—1935. During the last few years there has been an increasing demand for fuses with ratings lower than those covered by British Standard Specification 88. Such fuses are being used in plug heads and for protecting the circuits in radio receivers, railway signalling apparatus, and small domestic appliances, such as electric clocks, &c. A B.S.I. Committee was therefore appointed to prepare a standard specification, and the above-named recently issued specification is the result. The Electrical Research Association has been engaged for a considerable time on investigating the performance possibilities of cartridge fuses, and the new specification is based largely on the results of its work. Dimensions, ratings, and performance tests are all included.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Iron and Steel Imports.

The Board of Trade Returns for November disclose a considerable fall in the imports of iron and steel. This is due to the operation of the Anglo-Continental steel makers' agreement limiting the imports from Cartel countries to a quota. The total imports in November amounted to only 76,999 tons, compared with 104,086 tons in November, 1934, and show a reduction of 24,222 tons on the October total of 101,221 tons. There was a reduction in the imports of pig iron last month to 4459 tons, compared with 5906 tons in October. Of the November total 2696 tons came from British India. There was an increase, however, in the imports of ferro-alloys, which, in November, reached a total of 4017 tons, against 3551 tons in October. The largest quantity of 2010 tons came from Norway, Sweden being next with 1374 tons. The imports included 1371 tons of ferro-chromium and 1289 tons of ferro-silicon. No important variation occurred in the imports of blooms, billets, and slabs compared with the previous month, the figures being 21,582 tons and 24,563 tons respectively. Of the November quantity 8028 tons came from British countries, 6118 tons from Belgium, 4951 tons from France, and 1396 tons from Germany. Imports of sheet bars totalled 4862 tons compared with 4421 tons in October. The whole of the quantity last month with the exception of 6 tons came from Belgium. The imports of wire rods increased sharply to 6380 tons in November compared with 4725 tons in October. Girders, beams, joists and pillars were imported in November to the extent of 6707 tons, a substantial reduction from the October figure of 10,970 tons. Of the November total 4964 tons came from Belgium and 1194 tons from France. Imports of hoop and strip in November were also down from 5966 tons in October to 4590 tons. Belgium as usual sent the largest quantity of iron and steel into this country in November, the total being 30,866 tons, the next in importance being France with 8264 tons, Sweden being next with 6291 tons. Imports from Germany amounted to 6057 tons and from Norway to 2717 tons.

Exports in November.

Our exports in November were only fairly satisfactory at 215,835 tons, a reduction of 4000 tons on the total for November, 1934, and of 8198 tons on the October total of 224,033 tons. Exports of pig iron in November were practically the same as in October, the figures being 13,121 tons and 13,348 tons respectively. France was the best foreign customer, taking 1345 tons. The exports of general descriptions of steel were also maintained at about the October level, the figures being for November 19,781 tons and for October 20,740 tons. India was the best customer, taking 4168 tons, South Africa coming next with 2846 tons and Canada third with 1585 tons. Amongst foreign countries the Argentine took the largest quantity with 1037 tons. There was a slight increase in the exports of girders, beams, joists, and pillars at 2816 tons, compared with 2359 tons in October. Exports of hoop and strip dropped to 4854 tons from 5509 tons in October. There was also a decline in the exports of plates and sheets, not under ¼in. thick, from 16,800 tons in October to 13,829 tons. Of this quantity British India took 1150 tons in November, Russia 842 tons, and Canada 1656 tons. Plates and sheets under ¼in. thick were exported to the extent of 13,200 tons in November, against 15,557 tons in October. Of the November total 3147 tons went to the Argentine, 2244 tons to India, and 1784 tons to Canada. The exports of galvanised sheets showed a slight improvement, the figure for November being 23,626 tons, compared with 22,130 tons in the previous month, whilst exports of tin-plates declined to 30,240 tons from 33,683 tons in October. Exports of tubes, pipes, and fittings up to 6in. in diameter reached 5617 tons in November, compared with 5207 tons in October. The total exports of tubes amounted to 22,815 tons, a slight reduction upon the October figure of 24,355 tons. There was an increase, however, in the quantity of railway material sent abroad in November to 22,184 tons, compared with 20,253 tons in October. The November total included 12,656 tons of new steel rails, 2113 tons of sleepers and fish-plates, as well as 2590 tons of tires and axles. The best customer to Great Britain during November was South Africa with 33,421 tons. British India took 31,694 tons, Canada 21,108 tons, whilst amongst foreign countries the Argentine took the largest total with 11,198 tons, Denmark came next with 10,556 tons, Holland next with 4420 tons, and then Portuguese Africa with 2968 tons.

The Pig Iron Market.

The amount of business transacted this week has been negligible, as most buyers have avoided adding to their commitments immediately before the Christmas holidays. In fact, it is unlikely that any transactions of consequence will be entered into before early in the New Year. Many firms take stock at the end of December, and naturally wish to carry on their books only as much iron as is consistent with their nearby requirements. On the other hand, the market is in short supply, and although a number of consumers are more heavily bought forward than is usual at this season, they are by no means comfortable with regard to the future. Expectations that as a result of an advance in the price of coal the cost of producing pig iron will be materially increased have created a feeling of nervousness in the market. It seems to be generally anticipated that in the New Year more furnaces will be put into operation, but the pig iron producers so far have given no indication that they intend to increase their output. On the North-East Coast only two furnaces are engaged in producing foundry iron, and the make is insufficient to meet the demand in addition to contract engagements, whilst stocks have been reduced to narrow limits. During the next fortnight iron will go into stock as deliveries will be suspended over the holidays, but in all probability these will have to be resumed earlier than usual, and if the demand develops early in January, as is expected, the question of arranging for consumers' supplies will become urgent. In the case of Midland irons also the requirements of the market seem more than the present output can satisfy. A certain amount of Northamptonshire foundry iron is going to users on the North-East Coast, and it is reported that sales to Scottish consumers have reached substantial proportions during the past few weeks. This seems likely, since the delivered price at Glasgow and Falkirk is 1s. 3d. less than for Cleveland. In the Lancashire market conditions have been quiet for some time, but it is expected that consumers will shortly commence to buy. Many of the big users, however, are covered for some months to come. The Scottish demand keeps steady and the full make is passing into consumption. It is reported that the Scottish ironmasters contemplate putting more furnaces into commission. There has been no change in the position in the hematite market. It is not now expected that prices will advance before some time in January, but the view is that an increase will not be long delayed. This belief has led to heavy buying this month.

British Iron and Steel Production.

The British Iron and Steel Federation, in its statement for November, reports the production of pig iron during that month as 525,100 tons, compared with 544,300 tons in October and 507,600 tons in November, 1934. The output included 124,100 tons of hematite, 271,200 tons of basic, 108,000 tons of foundry, and 10,300 tons of forge iron. The production of steel totalled 903,300 tons, compared with 907,300 tons in October and 766,000 tons in November last year. At the end of October there were ninety-nine furnaces in blast, but one was brought into production at the beginning of November. This was at the works of the Charcoal Iron Company, of Barrow. During the month two other furnaces commenced operations, one at the Stanton Iron Company, Ltd., Nottingham, and one at the works of Dorman, Long and Co., Ltd., Middlesbrough. The following table shows the average monthly output of pig iron and steel over a period of years, and the production for the last four months :—

	Pig iron, tons.	Steel, tons.
1913—Monthly average	855,000	638,600
1920 " "	669,500	755,600
1929 " "	632,400	803,000
1932 " "	297,800	438,500
1933 " "	344,700	585,300
1934 " "	497,400	737,500
1935—August	543,400	759,900
September	529,600	855,900
October	544,300	907,300
November	525,100	903,300

Scotland and the North.

The shipyards on the Clyde have obtained a number of fresh orders, and since early in October over fifty contracts have been placed, representing a greater tonnage than that booked during all the preceding months of the year. These orders ensure that the steel makers will be kept busy well into the spring of next year. Already they have sufficient work in hand to tax their productive capacity, and large quantities of shipbuilding steel are being passed to the yards. The constructional engineers in Scotland are busy, and are taking good deliveries of joists and sections. Lately, a number of important structural contracts have been secured, and these will mean employment for this branch of the engineering industry for several months to come. Other sections of the trade also are actively engaged. The marine engineers in particular have taken attractive orders for propelling machinery, and for plant in connection with electrical undertakings. Perhaps the hardest worked section of the industry at the moment is the department producing semi-finished steel. The re-rollers' requirements of untested billets appear to be growing, and it has been difficult to meet their full demands. Business in steel bars is particularly heavy, the request being principally for bars for reinforced concrete work. Some export business is reported in this material, and the quotation is steady at £7 10s. f.o.b. Glasgow. This side of the market, however, has not been active. Most of the sheet mills are well employed and the motor car manufacturers have been good customers. There has been an improvement in the demand for the heavy gauges, but most of the business has been on home account and the export outlet remains unsatisfactory. In the Lancashire market so many consumers have covered their requirements over the first quarter of 1936 that little fresh business is offering. There is tremendous pressure upon the makers of billets in this district, and orders for prompt delivery are extremely difficult to place. No change has been made in the Association price of £5 10s. for 500-ton lots, untested, 100 tons of a size, but in many cases, if near delivery is possible, a figure in the neighbourhood of £6 is asked. Recently business in boiler plates began to expand, and the improvement has been maintained.

Current Business.

Barclay, Curle and Co., Ltd., Glasgow, have placed an order with Thomas Dunlop and Sons, Ltd., Glasgow, for a cargo motor ship of 9200 tons deadweight. The vessel will be fitted with Barclay, Curle-Doxford opposed piston oil engines. A contract for a bucket dredger has been placed by the London, Midland and Scottish Railway with William Simons and Co., Ltd., Renfrew. Richard Thomas and Co., Ltd., will take over full control of the Ynysmeudw Tinplate Works at Pontardawe on January 1st. The works, comprising four mills, were part of the Bryn Works, Ltd. The average output is 4000 boxes of tin-plates weekly. The Greenock Dockyard Company, Ltd., have received a further order from Clan Line Steamers, Ltd., for two twin-screw steamers of 10,000 tons deadweight. The vessels will be constructed to burn either coal and/or oil and will have triple-expansion machinery, with Bauer-Wach exhaust turbines, which will be supplied by J. G. Kincaid and Co., Ltd., of Greenock. Low Temperature Carbonisation, Ltd., in their annual report, state that sales of coalite show an increase of 14 per cent. over those for the previous year, ending October 31st. The process has been further improved and the works at Barugh and Askern carbonise 5000 tons of coal per week. The Metro-Coalite plant at Greenwich has an additional capacity to deal with 2000 tons of coal weekly. Orders for a further 270 trollybuses have been placed by the London Passenger Transport Board. William Cory and Son, Ltd., London, have ordered a 4350-ton cargo steamer from the Burntisland Shipbuilding Company, Ltd. The Department of Overseas Trade announces that the following contracts are open for tender :—Egypt, Ministry of Public Works : thirty petrol-paraffin pumping sets mounted on wheeled barrows (Cairo, January 15th) ; South Africa, Rand Water Board : one electrically driven induced draught fan with steam turbine as standby and accessories (Johannesburg, January 7th) ; South African Railways and Harbours : vacuum and steam pressure gauges and gauge dials, quadrants and pinions (Johannesburg, January 20th) ; Argentine State Oilfields Directorate : 181,500 m. of seamless external upset tubing, diameters ranging from 1¼in. to 3in.; supply and delivery of sucker and transmission rods and accessories for oil well services ; nine black steel drilling cables, eight ladle cables and six pulley cables (Buenos Aires, January 10th) ; Indian Stores Department : five vertical boilers (New Delhi, January 7th).

Copper and Tin.

In spite of the depressing influences arising from the international political situation, the uncertainty in the silver market and the approach of the holidays, the tone of the electrolytic copper market has been steady. In the United States consumers have bought rather spasmodically, probably in the belief that the American domestic price would be advanced. Business on the Continent, however, has been slow and there has been a general tendency to postpone purchases. British consumers have shown comparatively little interest in the market, and the buying which has taken place has been for delivery in January and further forward. Notwithstanding some price fluctuations, the market has had a firm undertone and the outlook seems favourable. Stocks are decreasing, and if the producers do not expand their production these should be reduced to normal limits during the next few months. Lately there have been rumours that some of the big producers contemplated increasing output, but this seems unlikely in view of the success of the agreement to restrict production. According to preliminary estimates, the American deliveries to domestic consumers in November were 52,000 tons, compared with 59,000 tons in October, whilst the deliveries outside the United States were 100,000 tons, compared with 105,450 tons in the previous month. Production in November is put at 137,000 tons, of which the American share was 56,100 tons. Prices in the standard market have fluctuated, largely as a result of the developments in the international situation. The undertone has been sound and when prices receded there was generally sufficient buying to check any pronounced fall. . . . Little change has occurred in the position in the tin market. Slightly easier conditions have resulted from the arrival of the Banca tin referred to last week ; but the prompt position is still tight and the backwardation keeps in the neighbourhood of £10. Buying by the Continent has become less active, and it is suggested that if the recent demand was the result of indirect sales to Italy it would appear that the Italians have secured as much tin as they want for the time being. American buying also has been rather poor, but this is a seasonal condition, and there are expectations that requirements will expand early in the New Year, as it is understood that consumers are not well covered.

Lead and Spelter.

The tone of the lead market has been on the easy side this week. Like other non-ferrous metal markets, it has been affected by the uncertain political outlook, whilst the confused state of the silver market has also reacted to the detriment of the lead position. Business with consumers in this country has noticeably declined, but it is due more than anything else to the fact that many firms take stock at the end of the year. Whilst this practice is not so general as in previous years, since there is a tendency now to take stock in March or September, it is still sufficient to have a distinct influence upon the market. The manufacturers of lead products, however, will close the year with a good tonnage of orders on their books, and there is little doubt that the industrial demand will again expand early in 1936. As is generally the case in December, more supplies of prompt lead have become available for the market. According to German figures, the world's smelter output of lead in October amounted to 120,780 metric tons, against 105,430 tons in September. Of this quantity the American production was 34,332 tons, 13,000 tons was Canadian, 19,400 tons Australian, 11,396 tons Mexican, and 10,278 tons German. . . . Conditions in the spelter market have not materially changed for the past week or two, and it is only natural that at the end of the year this market should be somewhat neglected. Consumers appear to have covered their requirements for some weeks to come and at the moment are showing little interest in the metal. There have been fresh arrivals of foreign spelter, principally Belgian. This, however, is not surprising, since markets which a year or two ago were open to Continental producers are now closed by quotas and other restrictions. London is practically the only existing free market and the quantities arriving here often have a depressing influence.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. COAST— Hematite Mixed Nos.	3 14 0 d/d Glasgow	
	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	7 10 0
Tees	9 10 0	8 10 0
Joists	8 17 6	7 10 0
Channels	8 15 6	7 15 0
Rounds, 3in. and up	9 10 0	8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	9 0 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½ per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 18th.

COPPER—	
Cash	£34 13 9 to £34 15 0
Three months	£35 2 6 to £35 3 9
Electrolytic	£39 0 0 to £39 10 0
Best Selected Ingots, d/d Birmingham	£39 0 0
Sheets, Hot Rolled	£66 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.

BRASS—	
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0

	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.

TIN—	
Cash	£220 15 0 to £221 0 0
Three months	£210 12 6 to £210 17 6
LEAD: Cash and forward	£16 15 0
SPELTER:	£14 18 9 to £15 1 3
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	16/– to 16/6
Hamilton Ell	19/– to 19/6
Navigation Splints	19/6 to 20/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/– to 16/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	16/–
Unscreened Navigation	16/– to 16/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/– to 17/6
Secondary Steam	16/– to 16/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/–
„ Second	14/6 to 15/–
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 14/–
DURHAM—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	25/– to 27/–	—
South Yorkshire Best	22/– to 24/–	—
South Yorkshire Seconds	19/– to 20/–	—
Rough Slacks	10/– to 11/–	—
Nutty Slacks	9/– to 10/–	—

CARDIFF— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/6
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Engineering Trades.

SIGNS of slight improvement in some industries do not extend to engineering, which, nevertheless, should benefit from the public loan of 2000 million francs which is issued for purposes of national defence. That money will be employed to clear up arrears and accelerate work in hand, such as naval construction, aircraft, equipment of aerodromes, and other defensive services that will provide employment in the engineering industries. The railways, too, are being helped to carry through the programme of improvements that are necessary in the public interest. The suppression of level crossings has been retarded by the high cost of such work, but it must be continued as part of the plan of road improvements which aim at avoiding cross traffic as much as possible. In the Seine Department it has been decided to suppress ten level crossings at an estimated cost of 65 million francs. This may appear a high figure, but at Colombes, in the Paris suburbs, the level crossings could only be suppressed satisfactorily by raising the level of the railway on a viaduct. So far as the Paris area is concerned a good deal of activity will be provided by the Exhibition of 1937, for which extensive works will be carried out, beginning with the construction of two permanent palaces, foot bridges across the Seine, filling the site of the abandoned Champs de Mars station, constructing docks below Auteuil to replace those along the river within the Exhibition grounds, besides road and other improvements. The absorption of the Paris-Sceaux railway by the Metropolitan railway will also involve the carrying out of important works for access to the Exhibition. Progress is being made with the widening of the Iéna Bridge from 34ft. 10in. to 114ft. 10in., as well as with the construction of the new Carrousel bridge in alignment with the opening through the Louvre to the Tuileries Gardens. There will also be an acceleration of public works that are intended to provide some activity until such time as plans can be carried through to facilitate foreign trade by suppressing quotas and replacing them with higher tariffs. As financial considerations impose a limit on public relief works the only hope of permanent recovery lies in removing obstacles to trade, and if quotas have not already been reduced or suppressed it is because the preparation of tariffs, in present circumstances, offers greater difficulties than had been supposed.

Motor Fuels.

The necessity of finding substitutes for imported oils has been strongly impressed on the public by events showing that a country's mechanised forces may be paralysed by an organised stoppage of foreign petrol supplies. That fear has long induced some Continental countries to make the fullest use of their own resources in liquid and gaseous fuels, and, while no satisfactory substitute has been found for mineral oils, emergency fuels are provided to a limited extent by alcohol and synthetic spirits which cannot normally supersede petrol on account of the cost. Vegetable oils are debarred for the same reason, as well as for their acidity, except when used in engines with special combustion chambers. Efforts are centred now more largely on suction gas from wood and charcoal, which has the advantage of cheapness, and its drawbacks have been partially eliminated by improved designs of producers, which are lighter, cleaner, and easier to maintain. The economy of suction gas appeals to users in parts of the country where wood and charcoal are readily procurable. All timber interests have combined to carry on a campaign in favour of "forest gas," with encouragement and help from the State, and two exhibitions of engines and vehicles and everything relating to the utilisation of wood and charcoal suction gas are to be held annually in different parts of the country. The first exhibition of the kind was held recently at Lyons. In the colonies the problem is of particular interest, and was a prominent feature of the first annual Colonial Exhibition which has just been closed in Paris. The production of petrol by the hydrogenation of coal was started last week at the Bethune colliery, where an experimental plant for dealing with 50 tons of coal a day has been put down by the Société Française des Essences Synthétiques. A similar installation will soon be completed for the same company at the Liévan colliery. These efforts to create a hydrogenation industry are subsidised by the State. In the Bouches-du-Rhône extensive lignite deposits can no longer be worked profitably because the sale of lignite has been curtailed by competition from northern collieries which have monopolised the market for patent fuels. The General Council of the Bouches-du-Rhône Department hopes to induce the State to experiment with the hydrogenation of lignite.

Public Service Vehicles.

One effect of the powers granted to the Government to issue decrees until the end of October last was to legalise measures that might otherwise have been held up, in the ordinary course of parliamentary procedure, for an indefinite period. Amongst the measures accelerated in this manner were those relating to public road transport, whereby private owners of lorries engaged in such service were granted temporary licences that could be withdrawn at any moment. The object of this arrangement is to limit the number of lorries and vans to what is required for public transport, and to bring them within the scheme of rail and road co-ordination which is being carried out all over the country. As a means of preventing any infraction of the law by lorry owners engaged in public transport, it has now been decreed that all public service vehicles must carry coloured discs before and behind, the colour red, green, and blue corresponding to the character of the services, whether regular, occasional, or exceptional, and lorries for goods transport must have rectangular plates, red in colour, if owned by the haulier, and green if hired, and those plates are required to indicate the district in which the vehicle is licensed to carry goods, while capital letters correspond to the categories of goods authorised to be carried. This restriction of public service vehicles has had a notable effect upon the heavy motor car trade, the sales of lorries having fallen considerably during the present year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

437,703. February 1st, 1935.—STARTING ENGINES OF THE LIQUID FUEL INJECTION TYPE, Robert Bosch Aktiengesellschaft, 4, Militärstrasse, Stuttgart, Germany.

This specification is concerned with the quick starting, from cold, of compression-ignition engines and begins with a rather illuminating explanation of the conditions, as determined by the inventors. They say that:—The assumption hitherto prevalent that by reducing the closing pressure the time required for the starting of the engine is shortened, is probably to be ascribed to the fact that when using very high closing pressures the injection pumps may have had a very poor degree of delivery at the slow starting speed, perhaps owing to imperfect construction. The quantity of fuel for which the pump was adjusted was thus perhaps not injected at all. It was only after reducing the closing pressure that an amount of fuel sufficient for the starting reached the combustion chamber. Not the reduction of the closing pressure, but the increase in the degree of pump delivery thus obtained during the starting period was thus the reason for the better starting. The conclusion generally drawn that with a reduced closing force a quicker starting is obtained thus did not fully take into account the causal circumstances. The circumstance that the starting period can be shortened by substantially doubling the closing pressure during the starting operation, in accordance with the invention, may perhaps be ascribed to the fact that thereby, on the one hand, a degree of atomisation more favourable for the ignition is obtained than

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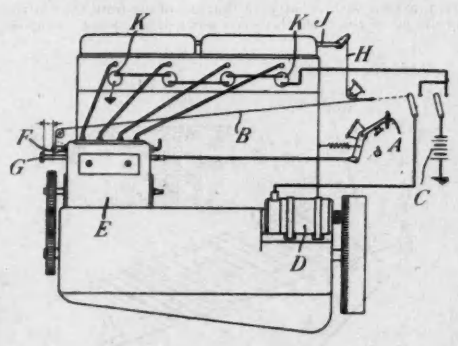

with the normal closing pressure, and, on the other hand, an improvement in the fuel jet more advantageous for the absorption of heat by the particles of fuel is produced. A substantially doubled closing pressure most favourable for starting will not, of course, be the best condition for running and power output. Nevertheless, this is offset by the facilitating of the starting. A further shortening of the starting operation can be obtained by adopting additionally to the above the known device of increasing the amount of fuel injected beyond the maximum amount injected when working under full loads at least for the duration of the starting. In the above-mentioned experiment with an engine having a pre-combustion chamber a substantial shortening of the starting period was obtained by increasing the amount injected to twice the full-load amount, which in that case amounts to about 55 cubic millimetres per each cylinder. By working with auxiliary ignition devices in the pre-combustion chamber, the amount of fuel injected during the starting operation could be still further increased, and thus the starting period still further shortened. The control of the engine is effected at starting by the pedal A and the cord B. C is a battery and D the starting motor. E is the fuel pump. On starting, the cord B is pulled and the stop pawl F thus raised, so that the collar G on the pump control rod can pass beyond the normal working position and when the pedal A is depressed to the full extent double the normal fuel supply is delivered. At the same time the branch cord H rotates the cam shaft J and doubles the compression on the springs of the injection valves. K K are electrically heated ignition plugs.—*November 4th*, 1935.

SWITCHGEAR.

437,650. May 2nd, 1934.—MERCURY ELECTRIC CUT-OUTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2; G. S. C. Lucas, 75, Eastlands-road, Rugby; and C. G. Mayo, 17, Alexandra-road, Rugby.

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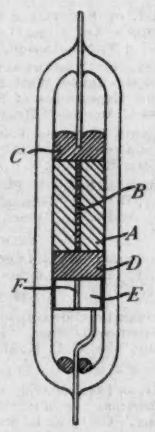

The object aimed at in the design of this cut-out is to ensure that the circuit can be remade without any fear of a bubble of gas in the capillary tube preventing the circuit being completed. The insulating block A has a capillary passage B, which is filled with mercury. A pool of mercury C, above it, is connected with one terminal. Another portion of mercury D is held up by a metal plug E connected with the other terminal. This plug also has a capillary bore F. Should the mercury column be ruptured by the evaporation caused by overloading, it can be re-set by shaking and should any gas interfere it will pass out through the capillary bore in the plug E. Any mercury which may escape into the bottom can be restored by inverting the cut-out and shaking it, or the cut-out may be made symmetrical and reversed.—*November 4th*, 1935.

437,713. May 23rd, 1935.—ELECTRIC SWITCH CONTACTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The object of this invention is to provide a switch contact which will not stick and arc during opening and closing. The switch contact A may be mounted on any suitable supporting means B and secured thereto either by mechanical means or by brazing. The contact member consists principally of silver and molybdenum, to which there is added a small amount of lead, preferably in the form of lead oxide. The addition of lead to the silver and molybdenum provides a contact substantially free from sticking and arcing. The ingredients of the alloy contact may vary considerably. The inventors have obtained satisfactory results with contacts containing about 0·5 per cent. to 20 per cent. lead oxide, the remainder of the contact consisting of silver and molybdenum. In such contacts the relative proportion of silver and molybdenum employed will depend upon the service to which the contact will be subjected. Very satisfactory results have been obtained with contacts containing about 95 per cent. silver, about 3 per cent. lead oxide, and about 2 per cent. molybdenum, also with contacts containing about 35 per cent. silver, 1 per cent. lead oxide, and 64 per cent. molybdenum. The contact is fabricated from powdered ingredients which are mixed together, pressed into a desired shape, and then sintered into a compact mass. The sintering temperature employed will vary with the composition of the alloy; for

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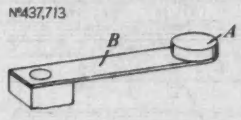

example, an alloy contact containing 95 per cent. silver, 3 per cent. lead oxide, and 2 per cent. molybdenum would be sintered at a temperature of about 735 deg. Cent. However, if the molybdenum content of the contact is increased a lower firing temperature is desirable. For example, an alloy contact containing 94 per cent. silver, 2 per cent. lead oxide, and 4 per cent. molybdenum would be fired at a temperature of about 700 deg. Cent. On the other hand, if the molybdenum content of the alloy is very high, as, for example, in an alloy contact containing 35 per cent. silver, 1 per cent. lead oxide, and 64 per cent. molybdenum, the firing temperature employed would be about 900 deg. Cent. In sintering the alloy contact a reducing atmosphere such as hydrogen is generally employed. However, if the alloy contains a low molybdenum content—for example, about 2 per cent.—it may be fired in an oxidising atmosphere if desired. The lead content in the alloy may vary from about 0·5 per cent. to 20 per cent. Preferably, however, from about 1 per cent. to about 3 per cent. lead in the form of lead oxide. If the lead content of the contact is greater than 3 per cent., the wear-resisting quality of the alloy is somewhat impaired.—*November 4th*, 1935.

AERONAUTICS.

437,692. September 21st, 1934.—THE MANUFACTURE OF HOLLOW AIRSCREW BLADES, The Bristol Aeroplane Company, Ltd., A. Hubert Roy Fedden, and F. M. Owner, Filton House, Bristol.

This invention is for improvements in the manufacture of hollow airscrew blades, and relates especially to blades of light alloy which are formed by a forging or like operation. A method of manufacturing a hollow airscrew blade consists in forging the blade about a former or core of different material, and subsequently removing the former or core by a chemical process. A bar or billet of magnesium alloy has formed in it a blind-ended hole, this being done by drilling, punching, up-setting, or other suitable method. The blind end of the hole is radiused or cup-shaped, and the adjacent outer end surface of the billet is trimmed to leave a suitable thickness of material around the end of the hole. The outer circumferential surface of the billet may, if desired, be machined or otherwise profiled to reduce the amount of work to be done in subsequent operations. An

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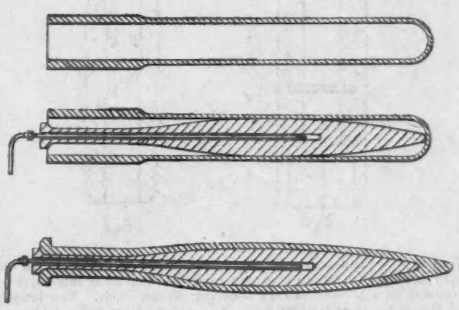

aluminium former, shaped to the desired inner contour of the blade, is passed into the hole and the billet is worked down on to this former, by forging, stamping, swaging or other process, or combination of processes. The blade, with the core *in situ*, is then immersed in a bath of caustic soda or caustic potash solution, which attacks and dissolves away the aluminium core without appreciably affecting the magnesium alloy, although the magnesium alloy may contain small quantities of aluminium. The time taken for the core to dissolve out may be reduced by drilling a hole or holes into the core from the root end of the blade. This operation also increases the area of aluminium exposed to the caustic solution. The aluminium former may be drilled or otherwise formed with passages in it, through which water or other cooling medium is circulated during the forging operations. These passages may also serve for the subsequent introduction of the chemical reagent. When the former has been entirely removed, the remaining operations are performed on the blade in their usual sequence. The illustrations need no comment.—*November 4th*, 1935.

METALLURGY.

437,695. November 19th, 1934.—THE ELIMINATION OF GASES FROM LIQUID SLAG, Dortmund-Hoerder Hüttenverein Aktiengesellschaft, Rheinischestr. 173, Dortmund, Germany.

In order to produce a dense slag of basaltic nature suitable

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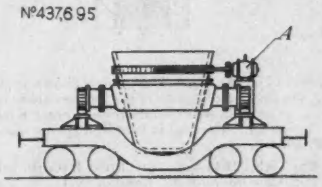


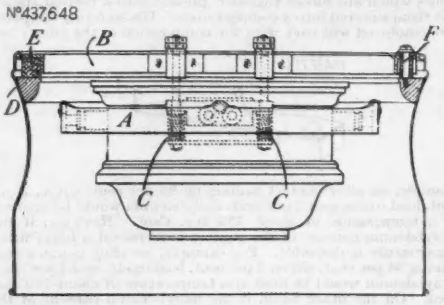
for road-making or concrete aggregate, the included gases are encouraged to escape by pouring the slag from a height of from 2 m. to 4 m. into a revolving ladle. The ladle is rotated by the motor A. By pouring the slag from a substantial height into a rotating ladle, so that the falling slag is distributed over a large

area of the ladle, the formation of a crust or coating on the surface of the slag, as occurs when slag is poured into a stationary ladle, and which prevents the escape of gases, is prevented. It will be understood that the centrifugal force produced by the rotating movement also assists in eliminating the gases from the slag.—*November 4th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

437,648. May 2nd, 1934.—The Suspension of Compasses in Gimbals, A. J. Hughes, Hainault Hall, Chigwell Row Essex, and Henry Hughes and Son, Ltd., 59, Fenchurch-street, London, E.C.3.

This invention aims at saving a ship's compass from the effects of vibrations which may be produced in the vessel's structure. This object is attained by supporting the gimbal



ring by two sets of resilient members having widely differing periodicities. The gimbal ring A is carried from the suspension ring B by the springs C C, which are in compression. The suspension ring is, in turn, supported from the binnacle D by the mousse rubber pads E. The fixing screws F are surrounded by rubber to prevent them transmitting vibrations to the ring B.—*November 4th*, 1935.

MISCELLANEOUS.

436,860. November 19th, 1934.—Blasting Explosive Devices, J. Taylor, 7, Winton-circus, Saltcoats, Ayreshire, W. Young, 118, Argyle-road, Saltcoats, and Imperial Chemical Industries, Ltd., Millbank, London, S.W.1.

This device is intended for use in the blasting of coal—for instance, by means of the release at a predetermined pressure of the gases produced by an explosion, or, otherwise, in a container inserted in the bore-hole. In Fig. 1 the upper part of the container is shown at A, and is given as 1¼in. external

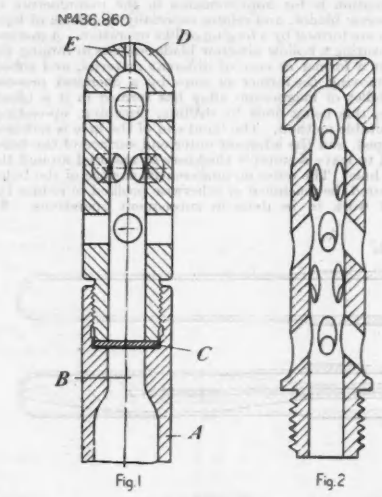


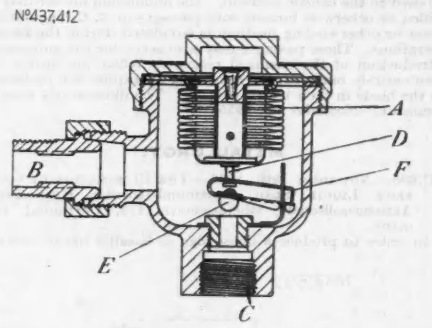
Fig.1

Fig.2

diameter, with a bore of 1¼in. At B there is a neck with an aperture of ⅜in., which is sealed by a disc C that is intended to rupture at a pressure of 13 tons per square inch. The length of the tube is about 20·5in. The screwed-on head D has a number of transverse openings ranging in area from two to four times the cross-sectional area of the container. A small opening E is provided so that the ruptured disc can be punched out should it stick in the bore. In Fig. 2 there is shown a preferred form of construction for the cap.—*October 21st*, 1935.

437,412. February 18th, 1935.—Steam Traps, B. H. Wingfield and B. T. Wingfield, Brooklyn, The Green, West Drayton, Middlesex.

This trap depends for its action on the expansion and contraction of a bellows A, which is filled with a liquid having a



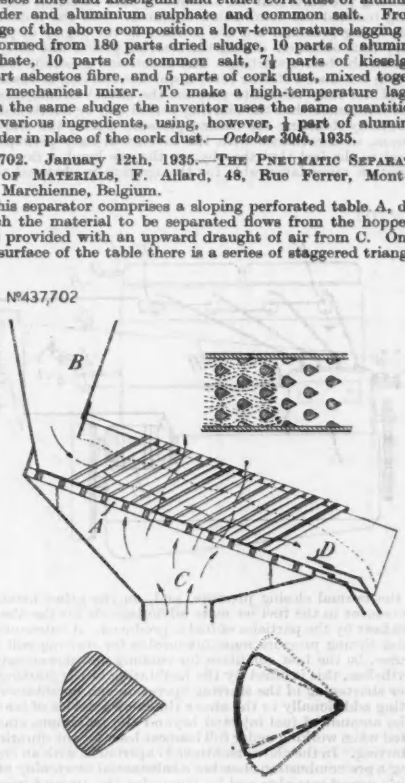
high coefficient of expansion. The inlet is shown at B and the outlet at C. On the bottom plate of the bellows there is a button D, which, when the bellows expands, presses down a ball valve E and closes the outlet. The ball is held in a spring-like arm F.—*October 29th*, 1935.

437,458. May 9th, 1934.—Steam Pipe Lagging, E. W. S. Press, 252, Caledonian-road, London, N.1.

The lagging with which this patent deals has as its basic raw material the sludge which is a by-product from the manufacture of paper, particularly from Esparto grass, and which may be a "lime sludge" or a "machine sludge." Whilst this sludge varies slightly in composition, a typical analysis is as follows:—Calcium carbonate, 83 per cent.; free carbon, 4·9 per cent.; iron and alumina, 1·5 per cent.; magnesium carbonate, 1·5 per cent.; sodium carbonate, 5·5 per cent.; moisture, 3·7 per cent. The sludge is first dried out at a temperature corresponding to about a steam pressure of 40 lb. per square inch, as it is originally conveyed from a dump, where the moisture content is sometimes as much as 15–20 per cent., and it is then mixed with asbestos fibre and kieselguhr. When the lagging is for use as a low-temperature lagging cork dust is added, but in lagging for high-temperature pipes a small quantity of aluminium powder is added in lieu of the cork dust, the cork dust or the aluminium powder being added and distributed through the mass by means of a mechanical mixer. The resulting mixture is a dry powder, which is then bagged ready for transport. The method of application of the material is to wet back this material to a soft sludge and apply it by hand directly to the hot surface to be lagged, the heat drying the lagging which adheres to the surface. It has been found that the hands of the workmen applying the lagging suffer from the effects of handling an alkaline material, such as soda ash containing perhaps some free lime. The percentage of the alkaline materials varies considerably and sometimes reaches 12–14 per cent. In order to neutralise this excess alkalinity common salt is added to the mix in addition to aluminium sulphate. The proportions of aluminium sulphate and salt vary according to the alkali content of the sludge, for aluminium sulphate neutralises its own weight of sodium carbonate, and the salt content will vary according to the quantity of aluminium sulphate which it is necessary to add. It is desirable for the mix to possess slight alkalinity and it is therefore necessary to add somewhat less aluminium sulphate than that necessary to neutralise the soda ash and free lime. In practice, therefore, the sludge is dried out as before, mixed with asbestos fibre and kieselguhr and either cork dust or aluminium powder and aluminium sulphate and common salt. From a sludge of the above composition a low-temperature lagging may be formed from 180 parts dried sludge, 10 parts of aluminium sulphate, 10 parts of common salt, 7½ parts of kieselguhr, 1 part asbestos fibre, and 5 parts of cork dust, mixed together in a mechanical mixer. To make a high-temperature lagging from the same sludge the inventor uses the same quantities of the various ingredients, using, however, ½ part of aluminium powder in place of the cork dust.—*October 30th*, 1935.

437,702. January 12th, 1935.—The Pneumatic Separation of Materials, F. Allard, 48, Rue Ferrer, Mont-sur-Marchienne, Belgium.

This separator comprises a sloping perforated table A, down which the material to be separated flows from the hopper B. It is provided with an upward draught of air from C. On the top surface of the table there is a series of staggered triangular



bars, as shown in the detail sketch. The inclination of these bars to the table is approximately 45 deg., but it may be varied by moving the connecting frame at the top—they are hinged to the table. As the material flows down it is classified into layers, which are separated by the knife D and distributed appropriately. There may be more than one separating knife.—*November 4th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of Electrical Engineers: N. Eastern Students' Section.—Armstrong College, Newcastle-upon-Tyne. "The Trend of System Design," Mr. F. C. Winfield. 7.15 p.m.

Inst. of Structural Engineers: Midland Counties Branch.—James Watt Memorial Inst., Birmingham. "Some Recent Experiences of Structural Engineering in the United States of America," Mr. H. C. Rowan. 6.30 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal meeting, "Film on Fabrication and Application of Hewittic Rectifiers." 7.30 p.m.

Physical Soc.—In Physics Dept., University College, Gower-street, W.C.1. "General Work of the Laboratory," Dr. E. N. Da C. Andrade. Papers. 4.30 for 5 p.m.

Saturday, Dec. 21st.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield, 1. Young People's Christmas Party. 3.30 p.m.

Saturday, Dec. 28th.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: I, Beginning of Photography," Dr. C. E. K. Mees. 3 p.m.

Tuesday, Dec. 31st.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: II, Modern Photography," Dr. C. E. K. Mees. 3 p.m.

1936.

Thursday, Jan. 2nd.

Inst. of Metals: Birmingham Local Section.—James Watt Memorial Inst., Birmingham. "Some Aspects of a Study of Steel Tubes," Dr. J. W. Jenkin. 7 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: III—Principles of Photography," Dr. C. E. K. Mees. 3 p.m.

Friday, Jan. 3rd.

Inst. of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Work of the National Physical Laboratory, with Special Reference to the Engineering Department," Dr. H. J. Gough, F.R.S. 7 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal discussion, "Prevention of Noise from Engineering Plant," Mr. D. W. McJannet. 7.30 p.m.

Saturday, Jan. 4th.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: IV—Motion Picture Photography," Dr. C. E. K. Mees. 3 p.m.

Monday, Jan. 6th.

Inst. of Production Engineers.—College of Technology, Manchester. "Industrial Relations," Mr. A. Ramsay. 7.30 p.m.

Tuesday, Jan. 7th.

Inst. of Automobile Engineers.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7.45 p.m.

Inst. of Automobile Engineers.—Graduates' meeting at Broadgate Café, Coventry. "Cooling Systems for Private Cars," Mr. J. Buchan. 7.15 p.m.

Inst. of Electrical Engineers: London Students.—Visit to Associated Newspaper Printing Works, Carmelite-House, E.C.4. 11 p.m.

Physical Soc.—Physics Lecture Theatre, Imperial College of Science and Technology, S. Kensington, S.W.7. "Some Instruments used in Recording Sound in Films," Mr. R. A. Bell. 7.45 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: V—Some Applications of Photography," Dr. C. E. K. Mees. 3 p.m.

Sheffield Metallurgical Assoc.—198, West-street, Sheffield, 1. Annual general meeting. 7.30 p.m.

Soc. of Glass Technology.—Trocadero Restaurant, London, W.1. Annual dinner and dance. 7 for 7.15 p.m.

Tuesday, Jan. 7th, to Thursday, Jan. 9th.

Physical Soc.—Imperial College of Science and Technology, S. Kensington, S.W.7. Annual Exhibition. Open daily: Tuesday, 3 to 6 p.m.; 7 to 10 p.m. Wednesday, 2 to 4 p.m.; 7 to 10 p.m. Members, 4 to 6 p.m. Thursday, 3 to 6 p.m.; 7 to 10 p.m.

Tuesday to Friday, Jan 7th to 10th.

Institute for Research in Agricultural Engineering.—Rhodes House, Oxford. Joint conference on "Mechanisation in Mixed Farming." Tuesday, Rhodes House. Inaugural dinner, 7.45 p.m. Wednesday, Thursday and Friday, 9.30 a.m.

Wednesday, Jan. 8th.

Inst. of Engineers-in-Charge.—St. Bride Inst., Bride-lane, E.C.4. "Boiler-house Efficiency," Mr. V. R. Chadwick. 6.30 for 7.30 p.m.

Inst. of Fuel.—At Chemical Soc., Burlington House, Piccadilly, W.1. "The Dedusting of Coal," Mr. G. Lindley. 6 p.m.

Physical Soc.—Physics Lecture Theatre, Imperial College of Science and Technology, S. Kensington, S.W.7. "Electrical Measurements before 1886," Mr. R. W. Paul. 7.45 p.m.

Thursday, Jan. 9th.

Inst. of Automobile Engineers.—Merchant Venturers' Technical College, Bristol. "Rotary Valves," Mr. R. C. Cross. 7 p.m.

Inst. of Automobile Engineers.—Derby Graduates' meeting at Technical College, Green-lane, Derby. "Some Notes on the Failures of Machine Components," Mr. D. Nelson. 7 p.m.

Inst. of Metals: London Local Section.—In Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Metals of the Platinum Group," Mr. R. H. Atkinson. 7.30 p.m.

Railway Club.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Story of a Railway Waif (the Invergarry and Fort Augustus Railway)," Mr. H. A. Vallance. 7.30 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1.—Christmas Lecture, "Photography: VI—Photography in Natural Colours," Dr. C. E. K. Mees. 3 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

United Water Softeners, Ltd., have opened new showrooms at 151, Regent-street, W.1, the Aldwych House showroom now being closed.

International Combustion, Ltd., has obtained a licence from the patentees for the manufacture and sale of the Cantieny high-pressure boiler. The licence covers this country and the British Empire. As distinct from some other recent developments in high-pressure boiler design, the Cantieny boiler works under natural circulation without exterior aids. It has already been built for capacities up to 260,000 lb. per hour evaporation at a pressure of 1917 lb. per square inch. The boiler may be fired by any known method, and the design is claimed to be readily adaptable to meet the requirements of any type of fuel or output.

LAUNCHES AND TRIAL TRIPS.

Kosarew, timber-carrying motor vessel; built by Netherland Shipbuilding Company, Ltd., to the order of Zentralvereinigung "Maschinormport," Moscow; dimensions, 92 m.; to carry timber in bulk. Oil engines; constructed by Maschinenfabriek Gebrs Stork and Co., Hengelo (O); launch, December 7th.

Philomel, steamship; built by Caledon Shipbuilding and Engineering Company, Ltd., Dundee, to the order of General Steam Navigation Company, Ltd., London; dimensions, 299ft. 9in. by 45ft. by 19ft. 9in.; deadweight, 3500 tons; gross tonnage, 2270 (approx.); to carry passengers and cargo. Engines, triple-expansion, developing 1800 i.h.p.; constructed by John G. Kincaid and Co., Ltd., Greenock; launch, December 9th.

Boltonhall, steamship; built by William Gray and Co., Ltd., to the order of the West Hartlepool Steam Navigation Company, Ltd.; dimensions, 421ft. 9in. by 54ft. 9in. by 27ft. 7in.; to carry cargo. Engines of improved C.M.E.W. "Quadropod" type; pressure, 260 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, December 12th.

Kanimbla, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of McIlwraith, McEacharn, Ltd., Australia; dimensions, 460ft. by 66ft. by 36ft.; to carry passengers and cargo. Diesel engines, of Harland-B. and W. type; constructed by the builders; launch, December 12th.